ROLE OF DIFFUSION WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN MYOMETRIAL PATHOLOGIES

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I hereby declare that the thesis entitled "**ROLE OF DIFFUSION WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN MYOMETRIAL PATHOLOGIES**" submitted towards partial fulfillment of the requirements for the award of **MD in RADIODIAGNOSIS** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. Chandan Kakkar**, Associate Professor, Department of Radiodiagnosis, **Dr. Kavita Saggar**, Professor & Head, Department of Radiodiagnosis, **Dr. Harpreet Kaur**, Professor & Head, Department of Pathology. No part of this thesis has formed the basis for the award of any degree previously.

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Dedicated

to

my Teachers

&

Family

ABBREVIATIONS

ADC	APPARENT DIFFUSION COEFFICIENT
AXIAL	AXIAL SECTION
CHESS	CHEMICAL SHIFT SELECTIVE FAT SUPPRESSION TECHNIQUE
COR	CORONAL SECTION
CT	COMPUTED TOMOGRAPHY
DWI	DIFFUSION-WEIGHTED IMAGING
EMJ	ENDOMYOMETRIAL JUNCTION
ESS	ENDOMETRIAL STROMAL SARCOMA
FOV	FIELD OF VIEW
LMS	LEIOMYOSARCOMA
MRI	MAGNETIC RESONANCE IMAGING
ROI	REGION OF INTEREST
SAG	SAGGITAL SECTION
SE-EPI	SPIN-ECHO ECHO-PLANAR SEQUENCE
SI	SIGNAL INTENSITY
SPSS	STATISTICAL PACKAGE FOR THE SOCIAL SCIENCE
STUMP	SMOOTH MUSCLE TUMOR OF UNKNOWN MALIGNANT POTENTIAL
TE	ECHO TIME
TR	REPETITION TIME
TRANS	TRANSVERSE SECTION
UAE	UTERINE ARTERY EMBOLISATION
USG	ULTRASOUND

ABSTRACT

Introduction: Myometrial pathologies are gynaecological ailments commonly occurring in females in the third decade of life. Owing to the difficulties associated with transvaginal needle biopsy for uterine smooth muscle tumors, and differential management protocol based on lesion pathology, preoperative diagnosis is important. Diffusion-weighted imaging (DWI) is an emerging technique used to visualize tissue characteristics based on the diffusion motion of water molecules, known as Brownian motion. ADC values calculated via Diffusion-weighted imaging (DWI) is a novel technique enabling potentially characterize of both benign and malignant myometrial pathologies based on their differential cellular milleu.

Aim of Study:

1.To study the signal pattern of myometrial pathologies on Diffusion Weighted Imaging(DWI).

2.To study the pattern of Apparent Diffusion Coefficient (ADC) values in different myometrial pathologies

Materials & methods: This study was carried out at Dayanand Medical College & Hospital, Ludhiana on the patients referred for pelvic MR imaging to the Department of Radiodiagnosis. The study was conducted for a duration of one year between March 2021 and February 2022 after the approval of the research committee and ethical committee.

All patients with myometrial pathologies detected on MR imaging were included post their written informed consent.

Results: The mean ADC value with standard deviation of the normal myometrium in our patients was 1493 +/- 392.48 $x10^{-6}$ mm^2/s and of all the various pathologies was 778.83 ± 288.41x 10^{-6} mm^2/s. Max cut off ADC value of 1007 $x10^{-6}$ mm^2/s was established to differentiate between pathological myometrium and normal myometrium which had an 88.04% sensitivity and 98.91% specificity and yielded an AUC of 95.4%.

Conclusion: DWI and ADC, appears to be a viable and trustworthy tool for identifying the features of myometrial lesions and delineating benign pathologies, with high specificity and sensitivity. A significant difference in the ADC values of adenomyosis, most variety of fibroids, and myometrium was obtained in our study. These differences may be exploited to differentiate adenomyosis from fibroids when the conventional imaging features are non-diagnostic.

Keywords: Diffusion weighted imaging (DWI), Apparent diffusion coefficient (ADC), Myometrial Carcinoma, Myometrium, Myometrial Lesions, Leiomyoma, Leiomyosarcoma

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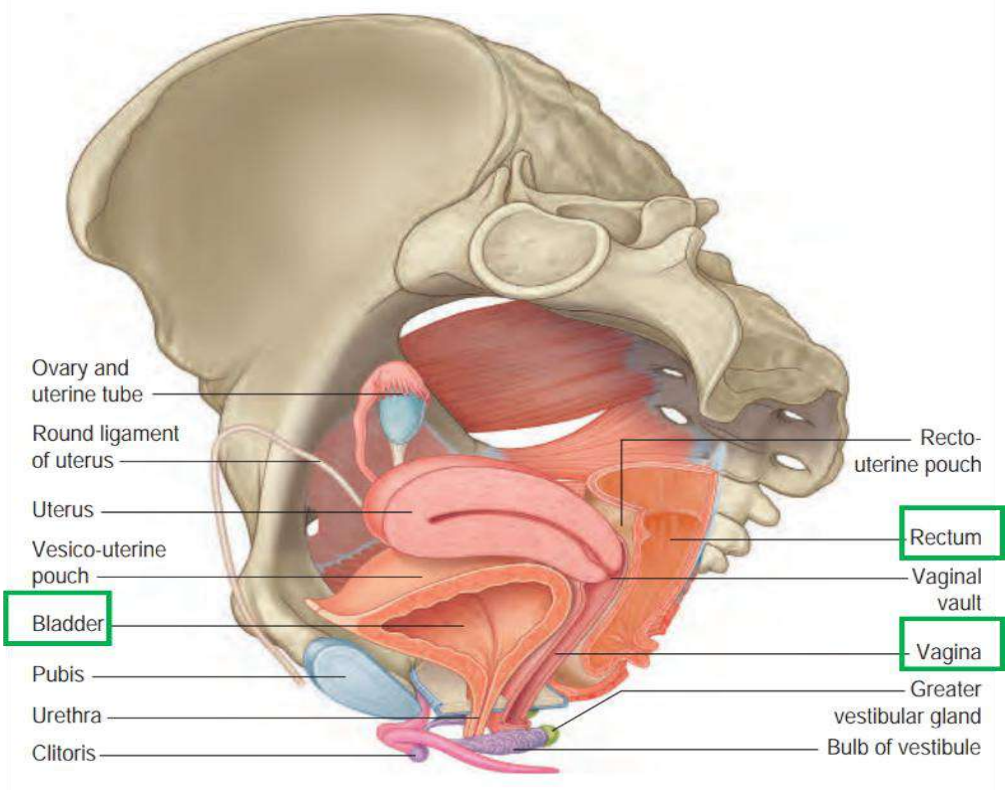
INTRODUCTION

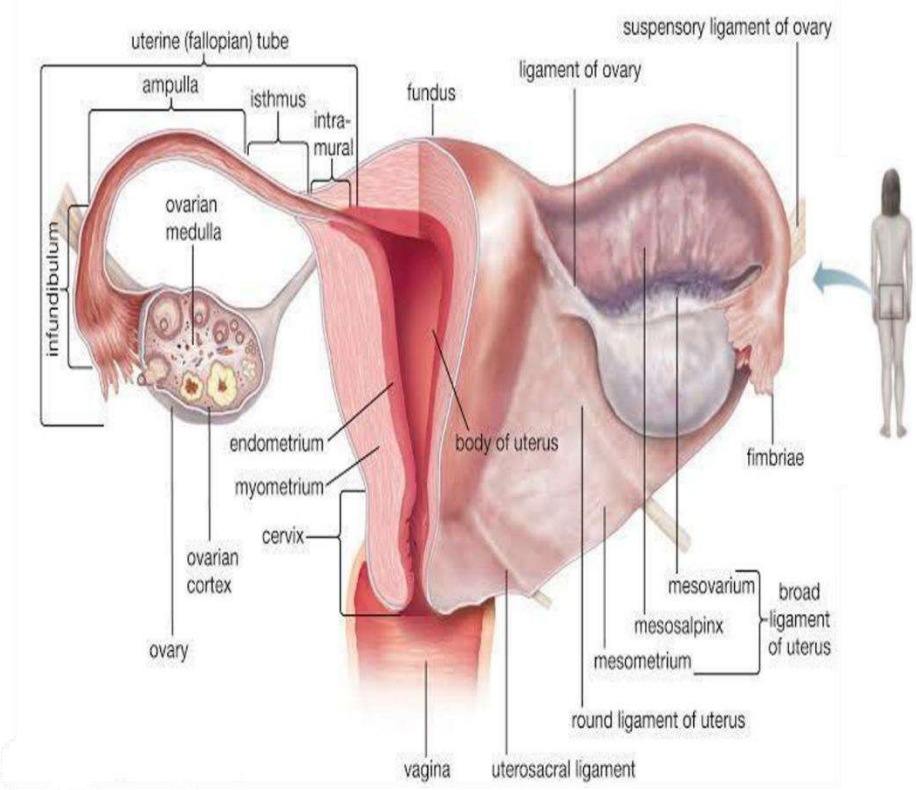
The uterus is a thick-walled, muscular organ which is a part of the female reproductive system situated in the pelvis between the urinary bladder and the rectum. The word “uterus” comes from the latin word for “womb”. During pregnancy the fetus develops within the uterus which provides it the necessary room for growth and development.

The uterus lies posterior to the bladder and uterovesical space, and anterior to the rectum and recto-uterine pouch. The exact anatomical location of the uterus varies with the degree of distension of the bladder. In the normal adult uterus, it can be described as anteverted with respect to the vagina, and anteflexed with respect to the cervix. The broad ligaments are lateral. It is connected distally to the vagina, and laterally to the uterine tubes.



Picture 1: Illustration of the uterus depicting the anatomical relations of the female genital tract, bladder and rectum.[1]

The body of the uterus is pear-shaped and extends from the fundus superiorly to the cervix inferiorly. The uterine tubes enter the uterus on both sides at the uterine cornua. The round and ovarian ligaments are inferoanterior and inferoposterior, respectively, to each cornua. The dome-like fundus is superior to the entry points of the uterine tubes and covered by peritoneum that is continuous with that of neighbouring surfaces. The fundus is in contact with coils of small intestine and, occasionally, by distended sigmoid colon. The lateral margins of the body are convex; on each side, their peritoneum is reflected laterally to form the broad ligament, which extends as a flat sheet to the pelvic wall.



Picture 2: Illustration of the uterus depicting in detail it's anatomical parts and surrounding structures.[2]

Table 1: Table depicting anatomical parts and surrounding structures of the uterus.

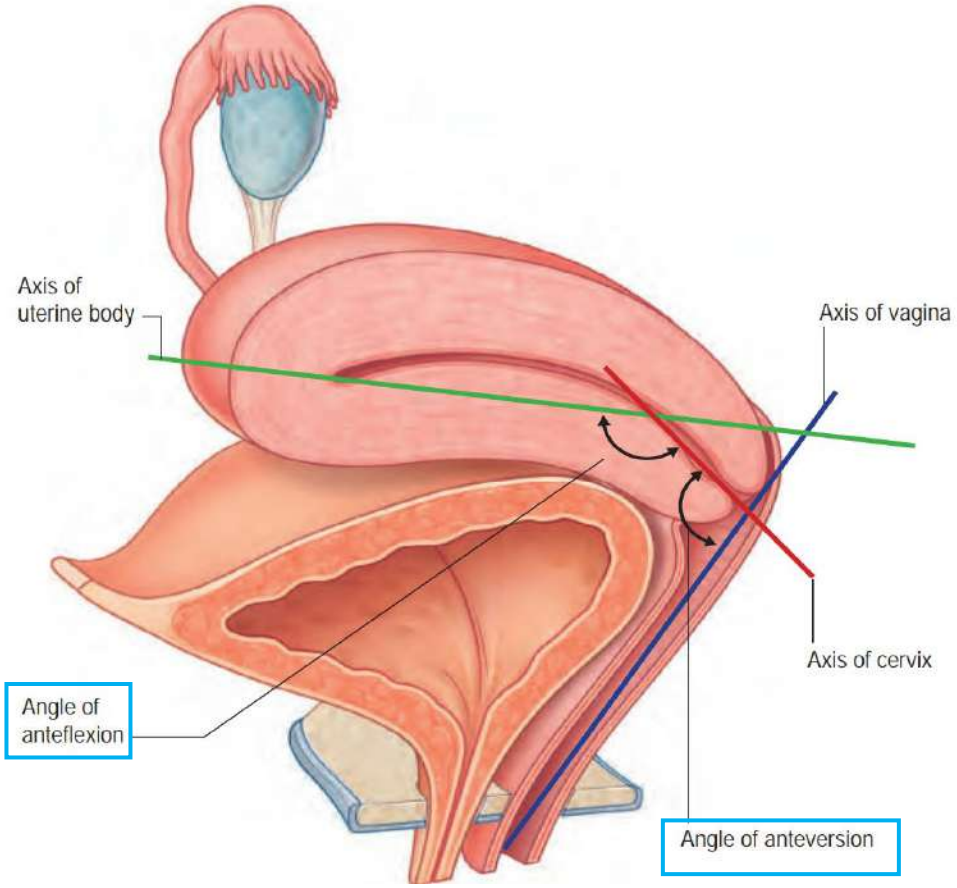
Parts	• **Fundus** – top of the uterus, above the entry point of the uterine tubes. • **Body** – usual site for implantation of the blastocyst. • **Cervix** – lower part of uterus linking it with the vagina. This part is structurally and functionally different to the rest of the uterus. **(Picture 2)**
Position and orientation	Anteflexion and anteversion **(Picture 3)**
Peritoneal recesses	• **Rectouterine (Douglas) pouch**: Reflection of peritoneum from rectum to upper part of posterior surface of vagina. • **Uterovesical (vesicouterine) pouch:** Reflection of peritoneum from uterus to upper surface of urinary bladder**.** • **Broad ligament of uterus:** Extension of peritoneum from lateral wall of uterus to lateral wall of pelvis, encloses the uterine tubes. **(Picture 4)**
Blood supply	Uterine arteries **(Picture 5)**
Venous drainage	Uterine venous plexus that flows into the internal iliac vein **(Picture 5)**

Innervation	Inferior hypogastric plexus
Lymphatics	iliac (external and internal), obturator, and para-aortic lymph nodes
Histology	Phases: proliferative and secretory Layers: • **Peritoneum** – a double layered membrane, continuous with the abdominal peritoneum. Also known as the perimetrium. • **Myometrium** – thick smooth muscle layer. Cells of this layer undergo hypertrophy and hyperplasia during pregnancy in preparation to expel the fetus at birth. • **Endometrium** – inner mucous membrane lining the uterus **(Picture 2)**

In most women, the long axis of uterus is bent forward on the long axis of vagina (anteversion of uterus). Also, the long axis of body of uterus is bent forward at the level of internal os with long axis of cervix (anteflexion of uterus).

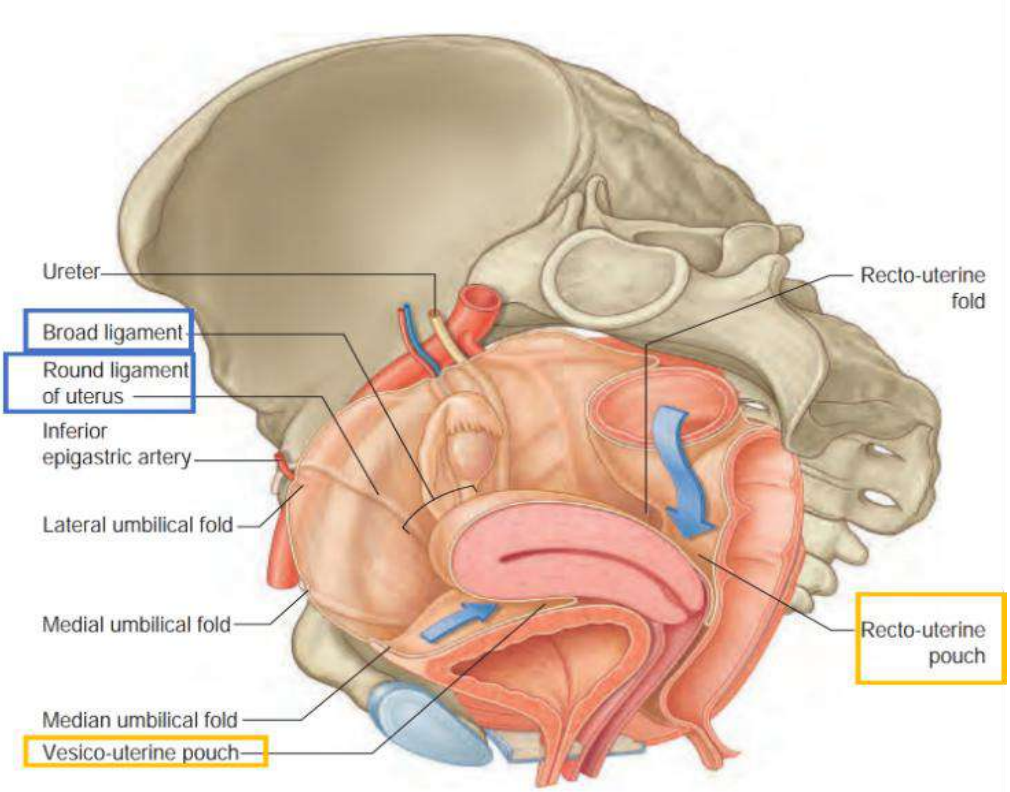
Thus, in erect position and with bladder empty, the uterus lies in an almost horizontal plane.

In some women,fundus and body of uterus are bent backward on vagina so that they lie in the rectouterine pouch (pouch of Douglas). Uterus is therefore retroverted. If body of uterus is, in addition, bent backward on cervix, it is also retroflexed.



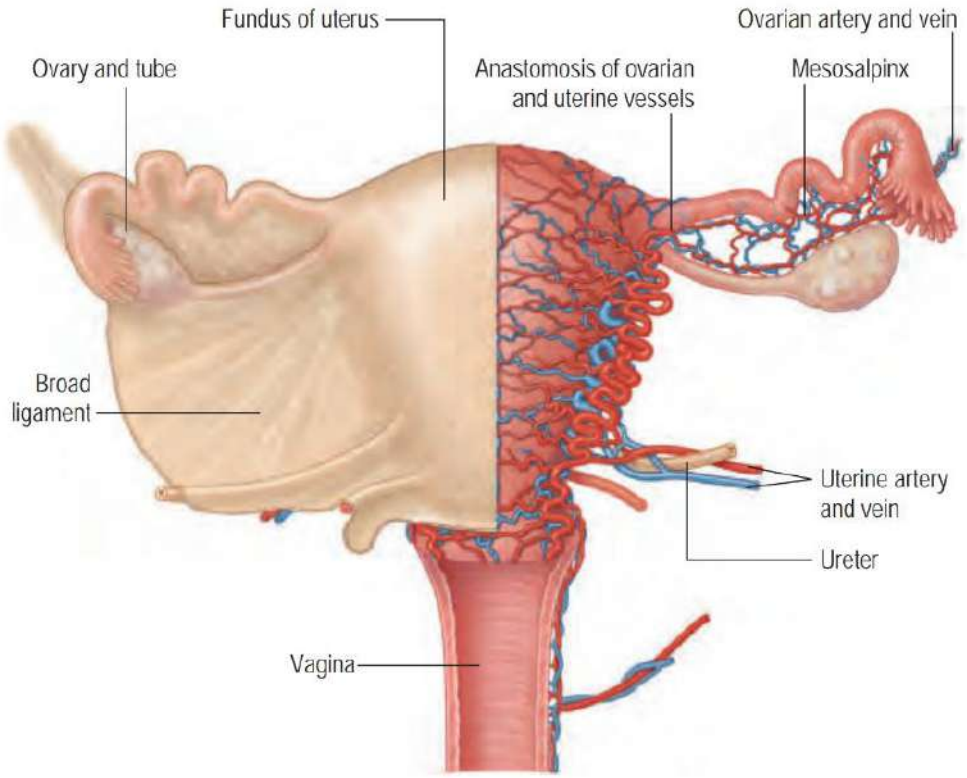
Picture 3: Angles of anteflexion and anteversion.[1]

The uterus is connected to a number of ligaments. Some are true ligaments i.e. they have a fibrous composition and provide support to the uterus, some provide no support to the uterus, and others are simply folds of peritoneum. The parietal peritoneum is reflected over the upper genital tract to produce anterior (uterovesical fold), posterior (rectovaginal fold) and lateral peritoneal folds(broad ligaments) (**Picture 4)**



Picture 4: Pelvic peritoneal reflections, showing the broad ligament and its contents.[1]

The anterior surface of the uterine body is covered by peritoneum reflected on to the bladder at the uterovesical fold. This normally occurs at the level of the internal os, the most inferior margin of the body of the uterus. The posterior surface of the uterus is convex transversely. Its peritoneal covering continues down to the cervix and upper vagina, and is then reflected back to the rectum along the surface of the recto-uterine pouch, which lies posterior to the uterus.



Picture 5: Arterial supply of uterus.[1]

Uterine smooth muscle pathologies i.e. myometrial pathologies are one of the common indications for female pelvic imaging. Most myometrial pathologies are benign leiomyomas and adenomyosis, which occur in women during their reproductive years. They are especially common and present at a younger age in black women.[3]

Uterine Fibroids or leiomyomas are the most common benign neoplasm of the uterus and arise from the smooth muscle layer and its accompanying connective tissue. Fibroidsare hormone-dependent, they usually increase gradually during the menstrual years and may decrease in size after menopause.[3] It is estimated that about 20–40% of women are diagnosed with fibroids but only a fraction of them are symptomatic and/or require treatment.[3] Uterine fibroids usually compress the surrounding myometrium, thus creating a pseudo-capsule from which the tumor can

easily be enucleated at the time of surgery.[4,5] Treatments may vary and include myomectomy, uterine artery embolization, and hysterectomy.[6]

Adenomyosis (endometriosis interna) is ectopic endometrial glands and stroma inter-digitating with the underlying myometrium with associated hypertrophy and hyperplasia of smooth muscle.[7,8] Adenomyosis is a common benign disorder, with an incidence of 40% or less in extirpated uteri.[7] It may be diffuse (throughout the uterus) or focal, where it is referred to as an adenomyoma.[3] Although minimally invasive therapies attempt to treat adenomyosis, surgical excision is difficult or impossible because the adenomyotic tissue interdigitates with the underlying myometrium.[7,8] Therefore, hysterectomy remains the definitive treatment for women with symptomatic adenomyosis.[9,10] For patients wanting to preserve fertility, hormonal manipulation provides symptomatic relief, but these effects are temporary, and symptoms tend to recur within 1 year of treatment cessation.[7] The clinical findings are dysmenorrhea, vaginal bleeding, and an irregular menstrual cycle with a tender bulky uterus.[3]

These two diseases often coexist together.[8] It has been reported that between 35% and 80% of adenomyotic uteri are accompanied by fibroids.[8]

Although frequently asymptomatic,they may present with pain, abnormal bleeding, abdominal distension, recurrent miscarriage, or subfertility. The symptoms depend to a certain extent on the site and size of the fibroids. Their location in the uterus is described as:[11]

1. submucousal- within the cavity.
2. mural- arising within the myometrium.
3. subserosal- deep to the serosa.
4. pedunculated- on a pedicle usually from the serosal surface.
5. cervical- rare.

Leiomyosarcoma (LMS) is a rare malignant tumor with an extremely poor prognosis and 5-year overall survival rates between 19% and 65%.[12,13] In contrast, leiomyomas are common benign tumors of the uterus, affecting

nearly 80% of women during their lifetime.[14] Another rare entity, uterine smooth muscle tumor with uncertain malignant potential (STUMP), is also clinically considered to have low malignant potential.[15] LMS/STUMP and benign leiomyomas share a similar clinical presentation as rapidly growing uterine tumors, leading to ~ 0.5% of resected tumors with a preoperative diagnosis of leiomyoma being unexpectedly revealed to be LMS based on final histopathology.[16] Preoperative diagnosis of uterine LMS/STUMP is increasingly important due to emerging non-hysterectomy options for symptomatic leiomyoma like laparoscopic myomectomy,[17] uterine artery embolization,[18] or high-intensity focused ultrasound.[19] Because the myometrial location of tumors renders tissue diagnosis from endometrial samplings extremely difficult, preoperative imaging diagnosis plays a crucial role.[20]

Magnetic resonance imaging (MRI) is well-accepted for imaging the female pelvis. It is robust for detecting, localizing, and staging uterine masses. Magnetic resonance imaging (MRI) is a meticulous tool for the assessment of uterine fibroids and adenomyosis and for gaining insight into their site, size, and characteristic signal intensity. In the majority of cases, it also excels at accurately differentiating adenomyosis from fibroids.[3,10] The signal characteristics and margins of these distinct pathological processes allow for a confident diagnosis in most cases. However, focal adenomyosis may be indistinguishable from fibroids even with MRI.[9,10] Clearly distinguishing between LMS/STUMP and benign leiomyomas by MRI also remains challenging due to the frequently atypical imaging features of these entities.[21,22]

Diffusion-weighted MRI (DWI) has shown promise in differentiating between LMS and leiomyomas,[23,24] making intravenous gadolinium contrast medium potentially unnecessary for the evaluation of patients with clinical suspicion of uterine LMS/STUMP. Similarly, it has proven to be useful for differentiating uterine fibroids and adenomyosis.

Moreover, diffusion-weighted imaging (DWI) has been very helpful in precisely localizing the pathology and predicting its aggressiveness. In recent years, diffusion-weighted imaging (DWI) with quantitative assessment of apparent diffusion coefficient (ADC) values has been incorporated into pelvic MR imaging protocols.[25]

$$\text{Degree of restriction to water diffusion} \propto \frac{1}{\text{tissue cellularity} + \text{intergrity of cell membranes}}$$

Diffusion-weighted imaging (DWI) is a magnetic resonance imaging (MRI) sequence structured based on the diffusion (Brownian motion) of water molecules in the extracellular space and is being increasingly used to evaluate the female pelvis. The quantitative parameter acquired from the DWI sequence is the apparent diffusion coefficient (ADC) value. The basic factors affecting ADC values are tissue structures, interactions between the molecules, and cellular density. Thus, ADC is altered by many physiological and pathological conditions of the body. DWI is acquired by the measurement of signal loss after a series of two motion-providing gradients (MPG) pulses with the addition of a 180° refocusing radio frequency pulse to both sides for enhancing the variations of molecular diffusion between tissues. The density of MPG pulses is shown by the b-value, a paramount criterion affecting the signal intensity of the DWI.[26-28] An appropriate b value is necessary for the female pelvic MRI.

DW-MRI is a functional imaging technique that does not require exogenous contrast medium administration.[28] This limits contrast-associated side effects and opens the usability of imaging modality.

Generally, densely packed tissues with high cellularity such as cancers have relatively little extracellular space thus leading to restricted water motion, and hence have lower ADC values compared to the benign lesions as well as normal tissue.[28] For example, in standard MRI typical leiomyomas appear as well-demarcated hypointense masses on T2-weighted magnetic resonance (MR) images. However, using MR imaging can make it difficult to distinguish leiomyomas from malignant tumors,

because some leiomyomas show hyperintensity on T2-weighted imaging (T2WI). Cellular leiomyoma is composed of dense cellular fascicles of smooth muscle with little intervening collagen.[29] This hypercellular nature and lack of collagenous tissue may contribute to increased signal intensity on T2WI.[28] Edematous degenerations in leiomyomas may show hyperintensity on T2WI. Malignant tumors including leiomyosarcomas often show hyper to heterogeneous signal intensity (SI) on T2WI because of correspondence to hemorrhage or necrosis.[27]

Distinguishing benign from malignant tumors based on routine MR examination is often difficult. On DWI, the increased cellularity may restrict water diffusion and thus decrease ADC.[7,29] Therefore, Diffusion-weighted imaging (DWI) is an emerging technique being used to visualize tissue characteristics based on Brownian motion.[27]

As the treatment of different myometrial lesions differs significantly, it becomes very important to make a specific diagnosis to guide patient management. Thus, the use of DWI-MRI, even though falling on the higher cost spectrum, will prove to be cost-effective as it reduces unnecessary surgical procedures by its superior ability to accurately identify and differentiate myometrial lesions.

So, the present study was undertaken with the motive to evaluate the utility of the apparent diffusion coefficient (ADC) in diagnosing myometrial pathologies identified by signal intensity (SI) on T2-weighted imaging (T2WI) and diffusion-weighted imaging (DWI), and determining the correlation between ADC and tumor cell density.

AIMS AND OBJECTIVES

1. To study the signal pattern of myometrial pathologies on Diffusion Weighted Imaging (DWI).
2. To study the pattern of Apparent Diffusion Coefficient (ADC) values in different myometrial pathologies.

REVIEW OF LITERATURE

DIFFUSION-WEIGHTED IMAGING

Diffusion-weighted imaging (DWI) is a magnetic resonance imaging (MRI) sequence structured based on diffusion (Brownian motion) of water molecules in the extracellular space and is being increasingly used to evaluate the female pelvis.

The quantitative parameter acquired from the DWI sequence is the apparent diffusion coefficient (ADC) value. The basic factors affecting ADC values are tissue structures, interactions between the molecules, and cellular density. Thus, ADC is altered by many physiological and pathological conditions of the body.[30, 31] In general simplified terms, highly cellular tissues or those with cellular swelling exhibit lower diffusion coefficients.

Apparent diffusion coefficient (ADC) is a measure of the magnitude of diffusion (of water molecules) within the tissue and is commonly clinically calculated using MRI with diffusion-weighted imaging (DWI).[32]

The uterus is a fibromuscular solid organ under the effect of hormones and is composed of three layers: the endometrial, the junctional, and the myometrial zones. Physiological (menstrual cycle, menopausal period) fluctuations of these zones change the ADC values used in the evaluation of uterine abnormalities.[31]

Diffusion is a multi-dimensional process, which occurs in different values in different directions depending on the microstructure of the tissues. Since uterine myometrium is composed of smooth muscle bundles and connective tissue diffusion reflects anisotropic features. Though DWI gives information about the direction of diffusion and cellularity of the tissue, anisotropic characteristics of tissues can be assessed appropriately by diffusion tensor imaging (DTI). It can be used to detect water diffusion directionality which in turn shows the microstructural architecture of normal and diseased tissue. Fractional anisotropy (FA) is the main quantitative parameter obtained from DTI data. Initially, DTI has been

used to show and evaluate the integrity of white matter tracts in neuroradiology. With the improvement of the MRI hardware and software and fast imaging techniques, after the use of DWI also DTI was implemented in abdominal imaging for some of the abdominal organs like the uterus.[30,32]

Physics[33]

As opposed to essentially free diffusion of water kept inside a container, diffusion of water inside brain tissue, for example, is hindered primarily by cell membrane boundaries. The overall diffusion characteristics of a single volume represent the combined water diffusion in several compartments:

- diffusion within the intracellular fluid
    - within the cytoplasm generally
    - within organelles
- diffusion within extracellular fluid
    - interstitial fluid
    - intravascular
    - lymph
    - various biological cavities, e.g. ventricles of the brain
- diffusion between intra- and extracellular compartments

The contribution of each one of these will depend on the tissue and pathology. For example, in acute cerebral infarction, it is believed that the decrease in ADC values is the result of a combination of water moving into the intracellular compartment (where its diffusion is more impeded by organelles than it is in the extracellular space) and the resulting cellular swelling narrowing the extracellular space [6]. Similar mechanisms result in low ADC values in highly cellular tumors (e.g. small round blue cell tumors (e.g. lymphoma/PNET) and high-grade gliomas (GBM)).

The further an individual water molecule diffuses during the sequence the more it will be exposed to varying gradient strength and the more it will be dephased reducing the amount of signal returned. This occurs at a much smaller scale than a single voxel. The strength of this effect (in other

words how much the signal will be attenuated by diffusion) is determined by the b value.

Basics

Diffusion-weighted imaging (DWI) exploits the random motion of water molecules. The extent of tissue cellularity and the presence of intact cell membrane help determine the impedance of water molecule diffusion. This impedance of water molecules' diffusion can be quantitatively assessed using the apparent diffusion coefficient (ADC) value. This assessment can be done using different b values via changing gradient amplitude.[33-36]

DWI is widely appreciated as an indispensable tool in the examination of the CNS. It is considered useful not only for the detection of acute ischemic stroke but also for the characterization and differentiation of brain tumors and intracranial infections.

Clinical application

Diffusion-weighted imaging has a major role in the following clinical situations:[37-39]

- early identification of ischemic stroke
- differentiation of acute from chronic stroke
- differentiation of acute stroke from other stroke mimics
- differentiation of an epidermoid cyst from an arachnoid cyst
- differentiation of abscess from necrotic tumors
- assessment of cortical lesions in Creutzfeldt-Jakob disease (CJD)
- differentiation of herpes encephalitis from diffuse temporal gliomas
- assessment of the extent of diffuse axonal injury
- grading of diffuse gliomas and meningiomas
- assessment of active demyelination
- grading of prostate lesions
- differentiation between cholesteatoma and otitis media

MRI sequence

A variety of techniques for generating diffusion maps have been developed. By far the most commonly used technique relies on a spin-echo echo-planar sequence (SE-EPI) although non-EPI techniques (e.g. turbo spin-echo) are also available and are of use, particularly where tissue is adjacent or within the bone where T2* effects cause artifact, distortion and signal loss on EPI sequences.[40-49]

The general principle of diffusion-weighted imaging

The fundamental idea behind diffusion-weighted imaging is the attenuation of the T2* signal based on how easily water molecules can diffuse in that region. The more easily water can diffuse (i.e. the further a water molecule can move around during the sequence) the less initial T2* signal will remain. For example, water within the cerebrospinal fluid (CSF) can diffuse very easily, so very little signal remains and the ventricles appear black. In contrast, water within brain parenchyma cannot move as easily due to cell membranes getting in the way, and therefore the initial T2* signal of the brain is only somewhat attenuated. An important consequence of this is that if a region of the brain has zero T2* signal it cannot, regardless of the diffusion characteristics of that tissue, show a signal on isotropic diffusion-weighted images.[50-63]

Diffusion information is extracted from the tissue by obtaining a T2* weighted image with no diffusion attenuation. This is known as the b=0 image.

Next, the ease with which water can diffuse is assessed in various directions; the minimum is 3 orthogonal directions (X, Y, and Z) and we will use this for the rest of this explanation.

This is done by applying a strong gradient symmetrically on either side of the 180-degree pulse. The degree of diffusion weighting is dependent primarily on the area under the diffusion gradients (which is in turn related to the amplitude and duration of the gradient) and on the interval between the gradients. The combination of these factors generates the b value.

The higher the number the more pronounced the diffusion-related signal attenuation.

Stationary water molecules acquire phase information by the application of the first gradient. After the 180-degree pulse, however, they are exposed to the same gradient (because they have not changed location) which undoes all the effects of the first (since they have flipped 180 degrees). Hence at the time the echo is generated, they have retained their signal.

Moving water molecules, on the other hand, acquire phase information by the first gradient but as they are moving when they are exposed to the second gradient they are not in the same location and thus are not exposed to precisely the same gradient after the 180-degree pulse. Hence they are not rephased and they lose some of their signals. The further they can move the less successful they will be rephased and the less signal will remain.

Generating isotropic DWI and ADC maps

The aforementioned process generates four sets of images: a T2* b=0 image and three diffusion-weighted images (one for each X, Y, and Z direction) with the T2* signal attenuated according to how easily water can diffuse in that direction.[64-72]

These images can then be combined arithmetically to generate maps that are devoid of directional information (isotropic): isotropic diffusion-weighted images (what we usually refer to as DWI) and ADC maps.

To generate the isotropic DWI maps, the geometric mean of the direction-specific images is calculated.

The ADC map, in contrast, is related to the natural logarithm (ln) of the isotropic DWI divided by the initial T2* signal (b=0). These can either be calculated directly from the isotropic DWI images or by finding the arithmetic mean of ADC values generated from each directional diffusion map.

Measurement

ADC values are calculated automatically by the software and then displayed as a parametric map that reflects the degree of diffusion of water molecules through different tissues. Then, by use of a dedicated workstation, ADC measurements are recorded for a given region by drawing regions of interest (ROIs) on the ADC map.[73-75]

An ADC of tissue is expressed in units of mm^2/s. There is no unanimity regarding the boundaries of the range of normal diffusion, but ADC values less than 1.0 to 1.1 x 10^{-3} mm^2/s (or 1000-1100 x 10^{-6} mm^2/s) are generally acknowledged in adults as indicating restriction. However, this is entirely dependent on the organ being imaged and the pathology.[76-81]

Some rough useful values (10^{-6} mm^2/s):[82-88]

- brain
    - white matter: 670-800
    - deep grey matter: 700-850
    - cortical grey matter: 800-1000
    - CSF: 3000-3400
    - astrocytoma
        - grade II: 1273 ± 293
        - grade III: 1067 ± 276
        - grade IV: 745 ± 135
- pelvis[88-91]
    - normal endometrial zone: 1530
    - benign endometrial lesions: 1300
        - uterine polyps: 1270-1580
    - endometrial cancer: 880-980[92-96]

Diffusion changes are correlated to the clinical deficit and are potentially useful for early diagnosis and longitudinal evaluation, especially in the context of pharmacological trials.[97-100]

Tamai et al[23] reported that DWI may be useful for discriminating uterine sarcomas from benign fibroids. The ADC values of the normal myometrial zone and degenerated fibroids were higher than uterine sarcomas and there was no overlap; however, there was an overlap with non-degenerated and cellular fibroids.[9] Pathological examination of the large fibroids with central necrosis revealed fibrosis. This finding was consistent with isotropic diffusion in DTI of the associated lesion. Fibrotic leiomyomas include non-parallel collagen fibrils, whereas well-structured collagen bundles were neighboring to smooth muscle cells in the normal myometrial zone. Irregularity of these collagen bundles could be the reason for the lower degree of anisotropy in the fibroids when compared with the neighboring myometrium.

The ADC values may also be beneficial for determining the therapeutic outcome after UAE, radiotherapy, and/or chemotherapy.[51] The effect of UAE or focused ultrasound may be evaluated by the detection of ablated tissue with DWI. The ADC values of fibroids after treatment are lower when compared with initial ADC values.

Liapi E et al., (2005)[5] evaluated the role of echoplanar diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) maps in the assessment of the response of uterine fibroids and myometrium to uterine fibroid embolization (UFE). They evaluated 32 fibroids in 11 patients treated with UFE. Treated lesions had low ADC values compared to untreated lesions. Furthermore, ADC values of the myometrium did not significantly change after embolization, suggesting maintained myometrial viability after embolization. DWI and ADC maps, by providing functional information at a cellular level, may serve as imaging tools for assessing treatment response after UFE.

Kilickesmez O et al., (2009)[4] performed a study to calculate the apparent diffusion coefficient (ADC) values of normal uterine zones as well as benign and malignant uterine diseases, and to determine a cut-off ADC value for the quantitative detection of uterine malignancies with DWI.

87 patients (mean age 53 years) with 107 benign and malignant uterine pathologies and 50 healthy controls (mean age 38 years) were enrolled in the study. DWI was performed with b factors of 0, 500, and 1000 s/mm2. The mean and the standard deviation of the ADC values of the control group were as follows: myometrium 1.76+/-0.19 x 10(-3) mm(2)/s, junctional zone 0.99+/-0.18 x 10(-3) mm(2)/s, endometrium 1.65+/-0.33 x 10(-3) mm(2)/s, and cervix 1.71+/-0.17 x 10(-3) mm(2)/s. There was a statistically significant difference among the ADC values of normal myometrium and leiomyomas (1.47+/-0.36 x 10(-3) mm(2)/s; P<0.009), endometrium and endometrial carcinomas (0.86+/-0.13 x 10(-3) mm(2)/s; P<0.001), myometrium-junctional zone and adenomyosis (1.24+/-0.20 x 10(-3) mm(2)/s; P<0.001), and cervix and cervical carcinomas (0.91+/-0.14 x 10(-3) mm(2)/s; P<0.001). The ADC values differed significantly between malignant (0.88+/-0.11) and benign lesions (1.55+/-0.33; P<0.01). A cut-off value for malignant lesions of 1.05 x 10(-3) mm(2)/s yielded a sensitivity, specificity, and accuracy of 95.83%, 94.55%, and 94.94%, respectively. The present study shows that ADC measurements have the potential to quantitatively differentiate between normal and cancerous tissues of the uterine zones.

Erdem G et al., (2009)[6] investigated and characterized the diffusional property of leiomyomatosis tissues with DWI. Sixteen females with a total of 21 leiomyomas were imaged with a 1.5-tesla clinical MR scanner. DWI images of leiomyomas, adjacent myometrial, and myometrial tissues of healthy controls were obtained and quantified using apparent diffusion coefficient (ADC) maps. The mean ADC values of these groups were 1201, 1684, and 1661 mm(2)/s x 10(-6), respectively. ADC values in leiomyomas were significantly lower than those observed in the myometrium ($p < 0.001$). Cut-off values produced 91% sensitivity and 100% specificity. As ADC values implied the presence of cytotoxic edema in leiomyomas, the technique was found to be promising in observing

temporal variations in leiomyomas and monitoring even the most subtle effects of therapeutic interventions.

Busard MP et al., (2010)[26] conducted a prospective single-center study to assess the value of magnetic resonance (MR)diffusion-weighted imaging (DWI) in the evaluation of deep infiltrating endometriosis (DIE). DWI was added to the standard MRI protocol in 56 consecutive patients with known or suspected endometriosis. Endometriotic lesions as well as (functional) ovarian cysts were analyzed for location, size, and signal intensity on T1, T2, and DWI. Apparent diffusion coefficient (ADC) values were calculated using b-values of 50, 400, 800, and 1200 s/mm(2). A total of 110 lesions (62 endometrial cysts and 48 DIE) were detected, 60 of which were large enough to analyze. Mean ADC values of endometrial cysts and functional ovarian cysts were 1.10 x 10(-3)/mm(2)/s and 2.14 x 10(-3)/mm(2)/s, respectively. Mean ADC values of DIE ectocervical, infiltrating the colon, and bladder was 0.70 x 10(-3)/mm(2)/s, 0.77 x 10(-3)/mm(2)/s, and 0.79 x 10(-3)/mm(2)/s, respectively. ADC values of DIE did not show a significant difference between varying pelvic locations (P = 0.63). Results of this study suggest that ADC values of DIE are consistently low, without significant difference between pelvic locations.

Jha RC et al., (2014)[27] evaluate differences, if any, in the apparent diffusion coefficient (ADC) values of fibroids and adenomyosis. Patients (n = 50) with uterine fibroids and adenomyosis (n = 43), who underwent pelvic MR imaging including DWI, were included in this IRB-approved HIPPA-compliant retrospective study. DWI was performed with b factors of 50, 400, and 800 s/mm using a 1.5 T scanner. ADC ROI measurements were placed over a fibroid, an area of adenomyosis, unaffected normal myometrium, skeletal muscle, and urine. Histogram analysis of ADC maps in 20 cases each of adenomyosis and fibroids were evaluated to assess the degree of tissue heterogeneity. The ADC values of adenomyosis and fibroids were compared using Student's t-test. The mean and the standard deviation of the ADC values of the control group were as follows: fibroid

0.64 ± 0.29, adenomyosis 0.86 ± 0.30, myometrium 1.39 ± 0.36, and urine 3.01 ± 0.2 × 10(-3) mm(2)/s. There was a statistically significant difference among the ADC values of normal myometrium and fibroids ($p < 0.0001$), normal myometrium and adenomyosis ($p < 0.0001$), and fibroids and adenomyosis ($p < 0.001$). Histogram analysis demonstrates less heterogeneity of adenomyosis as compared to fibroids. The present study shows that ADC measurements have the potential to quantitatively differentiate between fibroids and adenomyosis.

Sato K et al., (2014)[86] investigated the clinical usefulness of diffusion-weighted imaging (DWI) and the apparent diffusion coefficient (ADC) value for preoperative differentiation between uterine leiomyoma and leiomyosarcoma. This study included 10 lesions from 5 patients with pelvic leiomyosarcoma and 83 leiomyoma nodules from 76 patients, as identified by postoperative pathological examination (1 autopsy). The leiomyosarcoma lesions were readily apparent via DWI, presenting as an intermediate- to the high-intensity area in the uterine wall. All low-intensity areas presented as leiomyoma nodules. The mean ADC value for the 10 leiomyosarcoma lesions was 0.791 ± 0.145 (×10(-3) mm(2)/s), significantly lower than that of the leiomyoma nodules that presented with intermediate-intensity areas, 1.472 ± 0.285 (×10(-3) mm(2)/s) ($n = 41$) ($P < .001$), and high-intensity areas (1.100 ± 0.343) ($n = 9$) ($P = .03$). Additionally, in this study, the highest ADC value for a leiomyosarcoma was 1.095, with an intermediate DWI intensity. Based on these results, we classified the patients into 2 groups: the low-risk group (barely any leiomyosarcoma risk) and the high-risk group. Analyses comparing the 2 groups yielded the following: sensitivity, 100%; specificity, 94.0%; positive predictive value, 66.7%; negative predictive value, 100%; and accuracy, 94.6%. This study suggests that this modality using a combination of signal intensity on DWI and ADC value is very effective, simple, and easy to apply clinically for differential diagnosis of leiomyosarcoma and myoma.

Bakir B et al., (2014)[87] evaluated diffusion-weighted imaging (DWI) features and signal intensity values at T2-weighted magnetic resonance (MR) imaging for differential diagnosis of benign retroperitoneal fibrosis (RPF) and plaque-like retroperitoneal malignant neoplasms in a retrospective study. Fifty-one patients with plaque-like confluent retroperitoneal soft-tissue masses were divided into three groups: group I, 25 patients with malignant RPF and retroperitoneal malignant neoplasm; group II, 16 patients with chronic RPF; and group III, 10 patients with active RPF. On T1-weighted (unenhanced and contrast material-enhanced), T2-weighted, and DWI (b = 1000 sec/mm(2)) images, apparent diffusion coefficient (ADC) values and quotients of postcontrast signal intensities between lesions and psoas muscle were evaluated. Overall sensitivity, specificity, and positive and negative predictive values of DWI findings were 92% (23 of 25 patients), 62% (16 of 26 patients), 70% (23 of 33 patients), and 89% (16 of 18 patients), respectively. Mean ADC values were 0.79 ± 0.19 in group I, 1.43 ± 0.16 in group II, and 0.91 ± 0.14 in group III. When comparing values, differences between groups I and II (ADC values, P < .0001; DWI quotients, P < .0001; postcontrast quotients, P = .001) and groups II and III (ADC values, P < .0001; DWI quotients, P = .016; postcontrast quotients, P = .04) were significant. There was no significant difference between groups I and III or between the three groups when T2-weighted values were compared. This leads to the conclusion that ADC of chronic RPF was higher than that for active RPF or malignant RPF and retroperitoneal malignant neoplasm. DWI can contribute to the differential diagnosis of chronic RPF and malignant neoplasms with RPF morphology. Lesions in the malignant group and active RPF group had similar enhancement patterns, while those in the chronic RPF group demonstrated less enhancement. Signal intensity values on T2-weighted images were not useful for differentiating these conditions.

Tasaki A et al., (2015)[27] investigated the utility of the apparent diffusion coefficient (ADC) in differentiating benign and malignant uterine smooth muscle tumors classified by signal intensity (SI) on T2-weighted imaging (T2WI) and diffusion-weighted imaging (DWI), and to determine the correlation between ADC and tumor cell density. This retrospective study reviewed 168 lesions in 134 cases with pathologically confirmed uterine smooth muscle tumors, including 6 leiomyosarcomas and 3 smooth muscle tumors of uncertain malignant potential, and preoperative magnetic resonance imaging examinations performed between October 2009 and November 2012. T2WI and DWI were also performed for each subject. Tumors were then classified according to SI on T2WI and DWI relative to myometrial SI. The correlation between ADC and tumor cell density was also determined. In Group 1 (high on both T2WI/DWI), mean ADC was significantly lower for leiomyosarcoma (0.91 × 10(-3) mm(2)/s) than for leiomyoma (1.30 × 10(-3) mm(2)/s; $p < 0.05$) and mean cell density significantly higher for leiomyosarcoma (42.9%) than for leiomyoma (22.4%; $p < 0.05$). A strong negative correlation was seen between ADC and tumor cell density in Group 1 (Spearman, $R = -0.72$; $p < 0.05$). ADC may help to differentiate benign from malignant uterine smooth muscle tumors, particularly tumors with high SI on T2WI and DWI.

Yang D et al., (2016)[88] investigated the imaging features of uterine leiomyomas with different pathological subtypes on DWI. Clinical records and MR images of pathologically confirmed uterine leiomyomas were retrospectively collected. A total of 60 uterine leiomyomas were found and evaluated. All the patients were divided into three groups according to different pathological types, which included 17 cases of cellular leiomyomas, 10 cases of degenerated leiomyomas, and 33 cases of ordinary leiomyomas. The DWI signal and ADC values in the cellular portion of the lesions and adjacent normal myometrium (the control group) were measured. Results showed that: (1) Most cellular leiomyomas showed hyperintensity on DWI (15/17), while degenerated leiomyomas

manifested hypointensity, isointense or hyperintensity signal on DWI, and most ordinary leiomyomas displayed isointense signal on DWI (57.6%, 19/33). (2) The ADC values of cellular leiomyomas, degenerated leiomyomas, and ordinary leiomyomas were (1.01±0.14)×10(-3) mm(2)/s, (1.73±0.49)×10(-3) mm(2)/s and (1.38±0.22)×10(-3) mm(2)/s respectively. The ADC values of adjacent normal myometrium (the control group) were (1.35±0.16)×10(-3) mm(2)/s. There were no significant statistical differences in the ADC values between ordinary leiomyomas and adjacent normal myometrium (P=0.623). There were significant statistical differences in the ADC values among other groups(all P<0.05). (3) The ROC curve showed that the diagnostic threshold for cellular leiomyomas was 1.11×10(-3) mm(2)/s, and the sensitivity and specificity were 88.2% and 93.0% respectively. This suggests that the signal intensity on DWI and the ADC values are different in uterine leiomyomas with different pathological subtypes. A combination of these two parameters in clinical practice may be helpful to reflect the histopathological characteristics of uterine leiomyomas.

Tadros MY & Keriakos NN (2016)[89] conducted a trial to assess the role of ultrasound and magnetic resonance imaging including diffusion-weighted sequences in superficial and deep endometriosis. The study group included 30 patients who were previously clinically diagnosed to have endometriotic lesions. All patients were evaluated with ultrasound including pelvic and Transvaginal and conventional MRI with diffusion-weighted images. The sensitivity, specificity, and diagnostic accuracy for both examinations were calculated. Transabdominal ultrasound examination showed a sensitivity of 81%, and specificity of 38% with an overall accuracy rate of 73% while transvaginal US showed a sensitivity of 88%, specificity of 33%, and overall accuracy of 76%. By using conventional MRI the sensitivity showed an increase in sensitivity which was 85%, specificity which was 86%, and accuracy which was 85%. With the addition of diffusion weighted MRI sensitivity improved to 97%,

specificity to 86%, and overall accuracy to 95%. MRI is the most useful technique for determining the extent of endometriosis, especially in the ultrasonographically-indeterminate suspected masses and deep infiltrating lesions such as those of the ureters, bladder, and rectosigmoid.

Bader SJ and Kassim TA (2017)[91] assessed the differences, if any, in the apparent diffusion coefficient (ADC) values of adenomyosis and fibroids. Total patients of sample study 56, Patients (n= 25) diagnosed by ultrasound with uterine fibroids and (n=31) with adenomyosis, who underwent pelvic MR imaging with DWI, were included in this cross-sectional study. DWI was achieved using a 1.5 T scanner, different b factors of (0, 400, and 600 s/mm) and ADC region of interest (ROI) size were located over an area of adenomyosis, a fibroid, and unaffected normal myometrium all results are correlate with histopathological result which was considered as gold standard diagnostic methods. The standard deviation and the mean of the ADC values were as follows: adenomyosis 0.75 ± 0.30, fibroid 0.63 ± 0.29, and myometrium 1.39 ± 0.36. Statically, there was a significant difference between the ADC values of normal myometrium and adenomyosis ($p < 0.0001$), normal myometrium and fibroids ($p < 0.0001$), and fibroids and adenomyosis ($p < 0.001$). The present study display that ADC values can quantitatively and significantly differentiate between Adenomyosis and fibroids.

Lakhman Y et al., (2017)[92] retrospectively investigated whether qualitative magnetic resonance (MR) features can distinguish leiomyosarcoma (LMS) from atypical leiomyoma (ALM) and assess the feasibility of texture analysis (TA). This study included 41 women (ALM = 22, LMS = 19) imaged with MRI before surgery. Two readers (R1, R2) evaluated each lesion for qualitative MR features. Associations between MR features and LMS were evaluated with Fisher's exact test. Accuracy measures were calculated for the four most significant features. TA was performed for 24 patients (ALM = 14, LMS = 10) with uniform imaging following lesion segmentation on axial T2-weighted images. Texture

features were pre-selected using Wilcoxon signed-rank test with Bonferroni correction and analyzed with unsupervised clustering to separate LMS from ALM. Four qualitative MR features most strongly associated with LMS were nodular borders, hemorrhage, "T2 dark" area(s), and central unenhanced area(s) ($p \leq 0.0001$ for each feature/reader). The highest sensitivity [1.00 (95%CI:0.82-1.00)/0.95 (95%CI: 0.74-1.00)] and specificity [0.95 (95%CI:0.77-1.00)/1.00 (95%CI:0.85-1.00)] were achieved for R1/R2, respectively, when a lesion had ≥3 of these four features. Sixteen texture features differed significantly between LMS and ALM (p-values: <0.001-0.036). Unsupervised clustering achieved an accuracy of 0.75 (sensitivity: 0.70; specificity: 0.79). A combination of ≥3 qualitative MR features accurately distinguished LMS from ALM. TA was feasible.

Bakir B et al., (2017)[93] evaluated the role of diffusion-weighted imaging (DWI) in the diagnosis of various common pathologies of the uterine cavity, by comparing them with contrast-enhanced MRI findings. One hundred sixty-four patients with lesions in the endometrial cavity were included in the study. The patients were grouped into four (one malignant and three benign groups). We have observed that the differences in the apparent diffusion coefficient, b1000q, and Cq values between various common benign and malignant lesions were statistically significant (P<.001). However, the differences in the values between benign groups were not statistically significant (P>.05). Alternatively, the endometrial polyp group's signal intensity on DWI was different than the other groups.

Lin G et al., (2016)[100] performed research to compare the diagnostic accuracy of contrast-enhanced (CE) magnetic resonance imaging (MRI) and diffusion-weighted MRI (DWI) in the differentiation between uterine leiomyosarcoma (LMS) / smooth muscle tumor with uncertain malignant potential (STUMP) and benign leiomyoma. A consecutive cohort of 8 LMS/STUMP and 25 benign leiomyomas underwent a pelvic MRI exam at 3T. Two radiologists independently evaluated images based on CE-MRI

(central nonenhancement at equilibrial phase) and DWI (hyperintensity on b = 1000 s/mm2 and hypointensity on apparent diffusion coefficients [ADC] map). The ADC values were calculated from b = 0 and 1000 s/mm2. CE-MRI yielded a significantly superior diagnostic accuracy (0.94 vs. 0.52) and a significantly higher specificity (0.96 vs. 0.36) than DWI (P < 0.05 for both), and remained a comparably high sensitivity as DWI (0.88 vs. 1.00). A combination of DWI and ADC value <1.08 × 10(-3) mm2 /s (determined by receiver operating characteristic analysis) improved diagnostic accuracy, sensitivity, and specificity of DWI to 0.88, 0.88, and 0.88, respectively, by posthoc analysis based on the same study cohort. For prospective differentiation between uterine LMS/STUMP and benign leiomyoma, CE-MRI can provide accurate information and is preferable to DWI. A combination of DWI and ADC values can achieve comparable diagnostic accuracy to CE-MRI.

Huang YL et al., (2019)[28] retrospectively reviewed the preoperative pelvic MR images of consecutive patients who received histologically confirmed diagnoses of high-grade Endometrial stromal sarcoma (ESS) (n = 11) and low-grade ESS (n = 9) and T2-hyperintense leiomyoma (n = 16). Two radiologists independently evaluated imaging features in T1-, T2-, and diffusion-weighted and contrast-enhanced MR images. High-grade ESS was associated with significantly more extensive necrosis and hemorrhage and distinct feather-like enhancement compared with low-grade ESS (P < .05 for all). The feather-like enhancement pattern yielded a diagnostic accuracy of 95%, a sensitivity of 91%, and a specificity of 100% in differentiating high-grade from low-grade ESS. This imaging characteristic was significantly superior to necrosis (80%, P = .033) or hemorrhage (75%, P = .007). Both high- and low-grade ESS demonstrated T2 hypointense bands, marginal nodules, intratumoral nodules, and worm-like intra-myometrial nodules, and their tumor apparent diffusion coefficient (ADC) values were significantly lower than those of T2-hyperintense leiomyomas (P < .001). Diffusion-weighted MR

imaging is useful in diagnosing ESS against T2-hyperintense leiomyomas, and contrast enhancement aid in further differentiating between high- and low-grade ESS.

Onal Y, Samanci C (2019)[94] performed a prospective study including a total of 90 patients, 27 with malign gastric pathologies 63 with benign gastric pathologies with Gastric Wall (GW) thickening in multidetector CT, were evaluated by T2 weighted axial MR imaging and Diffusion-Weighted Imaging (DWI). Measurements were made both from the thickened wall and the normal GW. Also, a new method called GW/spine ADC ratio was performed in image analysis. The value found after ADC measurement from the GW was proportioned to the spinal cord ADC value in the same section. The ADC values measured from the pathological wall in patients with gastric malignancy (1.115 ± 0.156 x10-3 mm2/s) were significantly lower than the healthy wall measurements (1.621 ± 0.292 × 10-3 mm2/s) and benign gastric diseases (1.790± 0.359 x10-3 mm2/s). GW/spine ADC ratio was also lower in the gastric malignancy group. ADC measurement in DWI can be used to distinguish between benign and malignant gastric pathologies.

Abdel Wahab C et al., (2020)[95] performed a case-control retrospective study to develop a diagnostic algorithm including diffusion-weighted MRI criteria to differentiate malignant uterine sarcomas from benign atypical leiomyomas. This study identified women with an atypical uterine mass at MRI, with surgery or MRI follow-up after 1 year or longer. A diagnostic algorithm including T2-weighted MRI and diffusion-weighted imaging (DWI) signal and apparent diffusion coefficient (ADC) values was developed to predict sarcoma. The training set consisted of 51 sarcomas and 105 leiomyomas. Two external validation sets were used to evaluate interreader reproducibility (16 sarcomas; 26 leiomyomas) and the impact of reader experience (29 sarcomas; 30 leiomyomas). Wilson confidence intervals (CIs) were calculated for sensitivity and specificity. Evaluated were 156 women (median age, 50 years; interquartile range, 44-63 years).

Predictive MRI criteria for malignancy were enlarged lymph nodes or peritoneal implants, high DWI signal greater than that in the endometrium, and ADC less than or equal to 0.905 × 10-3 mm2/sec. Conversely, a global or focal area of low T2 signal intensity and a low or an intermediate DWI signal less than that in the endometrium or lymph nodes allowed readers to confidently diagnose as benign a uterine mass demonstrating one or more of these signs ($P < .001$) in 100% cases in all three data sets. The sensitivities and specificities of the algorithm for diagnosis of malignancy were 98% (50 of 51 masses; 95% CI: 90%, 100%) and 94% (99 of 105 masses; 95% CI: 88%, 98%) in the training set; 88% (14 of 16 masses; 95% CI: 64%, 97%) and 100% (26 of 26 masses; 95% CI: 87%, 100%) in the validation set; and 83% (24 of 29 masses; 95% CI: 65%, 92%) and 97% (29 of 30 masses; 95% CI: 83%, 99%) for the less experienced reader, respectively. A diagnostic algorithm with predictive features including lymphadenopathy, high diffusion-weighted imaging signal concerning the endometrium, and low apparent diffusion coefficient enabled differentiation of malignant sarcomas from atypical leiomyomas.

Reyes-Pérez JA et al., (2020)[96] conducted a retrospective study to determine whether ADC values in EC diverge according to the tumor's histologic grade and myometrial invasion depth. A sample of 48 pathologically confirmed cases of EC were reviewed. The sample was distributed as follows: G1 (n = 9); G2 (n = 18); G3 (n = 21); with myometrial invasion <50% (n = 31); and with myometrial invasion ≥50% (n = 17). DW images were performed at 3.0T with b factors of 0-1000/mm2. The region of interest (ROI) was defined within the tumor with T1-weighted and T2-weighted imaging and copied manually to an ADC map. The tumor's grade and myometrial invasion's depth were determined by postoperative histopathological tests. The means of ADCmin and ADCmean values were significantly lower for patients with G2 and G3 endometrial tumors than for G1. The same tendency was observed in the myometrial invasion, as both ADCmin and ADCmean values were lower

for patients with deep than for those with superficial myometrial invasion. The cut-off values of the ADCmin and ADCmean that predicted high-grade tumors were 0.69 × 10^{-3} mm^2/s and 0.82 × 10-3 mm2/s, respectively, while those for myometrial infiltration were 0.70 × 10-3 mm2/s (ADCmin) and 0.88 × 10-3 mm2/s (ADCmean). ADCmin and ADCmean values correlated with histologic tumor grade and myometrial invasion depth; therefore, it is suggested that ADC on MRI may be a useful indicator to predict the malignancy of ECs.

Ahmed SE et al., (2022)[98] conducted a study to determine the efficacy of MRI with DWI in improving the diagnostic accuracy of endometrial focal lesions, especially in the differential diagnosis of benign and malignant focal endometrial masses. This study recruited 36 women (21 postmenopausal and 15 premenopausal) who experienced vaginal bleeding and had the endometrial thickness and focal endometrial lesions with a distinct echo pattern on ultrasound (US) examination. The age of patients was between 27 to 85 years, with an average of 45.2 years. Ethics Committee approval was obtained in addition to written informed consent from all included patients. The 36 patients included in this study, were classified according to their lesions' histopathological results; the Benign group (15 lesions; 41.67%) and the malignant group (21 lesions; 58.33%). The most common benign lesion was endometrial polyp (9/15) while the most common malignant lesion was endometrial carcinoma (21/21). In the current study MRI with diffusion could correctly diagnose 33 lesions out of 36 lesions, achieving (91.6%) sensitivity, (100%) specificity, (100%) positive predictive value (PPV), (95.6%) negative predictive value (NPV), and accuracy (97.05 %). Integrating DWI and ADC mapping at a high b value in pelvic MRI examination improves the sensitivity, specificity, and precision of diagnosing endometrial focal lesions.

MATERIAL AND METHODS

Source of Data

This study was carried out at Dayanand Medical College & Hospital, Ludhiana on the patients referred for pelvic MR imaging to the Department of Radiodiagnosis. The study was conducted for a duration of one year between March 2021 and February 2022 after the approval of the research committee and ethical committee.

METHOD OF COLLECTION OF DATA

52 patients were referred for pelvic MR imaging, recruited & evaluation was done, to study the role of diffusion-weighted imaging and apparent diffusion coefficient in myometrial pathologies, after getting approval from IEC (Institutional Ethical Committee).

ETHICAL CLEARANCE AND CONFIDENTIALITY: The ethical clearance for the study was taken by the Institutional Review Board for Ethical Clearance of Dayanand Medical College & Hospital, Ludhiana (Punjab). All the subjects /attendants were explained the procedure involved and the purpose of the study. All consenting patients /attendants were asked to sign a written informed consent form (in the language best understood by them). The information regarding each patient was kept confidential and was not revealed at any point in time.

INCLUSION CRITERIA:

- All female patients with myometrial pathologies were detected on pelvic MRI.
- Clinical, surgical, and histopathological follow-up wherever possible.

EXCLUSION CRITERIA:

- Patients with endometrial cancer and myometrial invasion.
- Patients in whom ADC measurements of myometrium are not possible due to technical factors.

- All patients with contraindications for MRI (having cardiac pacemakers, prosthetic heart valves, cochlear implants or any metallic implants, having a history of claustrophobia)
- All patients who do not consent to be a part of the study.

MAGNETIC RESONANCE IMAGING PROTOCOL:

All patients underwent a multiplanar, multi-sequential MRI scan of the pelvis on a MAGNETOM SKYRA 48 Channel 3 Tesla MRI Scanner by Siemens, Germany.

MR Imaging sequences included a) T2 Weighted Sagittal b) T2 Weighted Axial c) T2 Weighted Coronal d) T1 Axial Imaging e)Diffusion Weighted Imaging (DWI) in Sagittal and Axial plane acquired at 0,400 and 800 extrapolated to 1400-1600 by inbuilt software f) contrast-enhanced imaging: on discretion.

ADC was calculated using DWI in many previous studies based on a mono-exponential equation using only 2-point b-values (with zero as the low b-value) in pelvic MR imaging for women. ADCs calculated using this approach consist of a mixture of perfusion and diffusion information. Some studies have reported ADCs using multiple b-values in various organs. According to the intravoxel incoherent motion (IVIM) DWI model, pure extravascular molecular diffusion and the microcirculation of blood within the capillaries (perfusion) can be separated using a biexponential decay function, providing additional parameters for characterization. Therefore, in the present study ADCs were calculated using a bi-exponential equation using multi-b-values, including those of myometrial tumors.[27] Hence ADC values were acquired at 3 b-values of 0,400,800 s/mm^2.

IMAGE ANALYSIS PROTOCOL:

- For Diffusion-Weighted Imaging:By far the most commonly used technique relies on a spin-echo echo-planar sequence (SE-EPI)

It was performed in the axial plane of the uterus with a (single-shot echo planar imaging (EPI)) sequence using the following parameters: repetition time (TR)/echo time (TE), 8000 ms/99 ms; 5 mm slice thickness; field of view (FOV), 260 mm; matrix, 128646; and bandwidth, 1346 (Hz/Pz).

The images were acquired using three different high b-values (b 0, 400, and 800 smm^{-2}) and the chemical shift selective fat suppression (CHESS) technique.

- For quantitative analysis:

The diffusion weighted images were reviewed with the conventional MR images (T2W images) for precise localization of the myometrial lesion. Then ADC values of the diseased myometrium were measured on the ADC map images by placing two regions of interest (ROI) of average size 2-4 mm^2 within the lesion excluding areas of necrosis, hemorrhage, and cystic changes (as they impede accurate cell density evaluation).Two regions of interest (ROI) of average size 2-4 mm^2 werealso placed in the normal myometrium.

We measured two ROIs and used the average value, to reduce random variability in the measurements.

STATISTICAL ANALYSIS:

Data was described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases), and relative frequencies (percentages) as appropriate. Comparison of quantitative variables between the normal and the pathological myometrium was done using Mann-Whitney U test and ANOVA (Analysis of Variance). Sensitivity, specificity, positive and negative predictive values, and accuracy of the method and its confidence interval (95% CI) were calculated for the normal and pathological myometrium. A probability value (p-value) less than 0.05 was considered statistically significant. All statistical calculations were done using SPSS (Statistical Package for the Social Science) 21 version statistical program for Microsoft Windows.

OBSERVATIONS AND RESULTS

A. AGE DISTRIBUTION

The current study was conducted on 52 patients for a duration of one year between March 2021 and February 2022. The patients in our study were between the age group of 18 to 60 years and presented to us with varying pelvic symptoms.

The maximum number of patients/casesin the present study i.e. 22 people(42.3%) were between 41-50 years of age while 13 people (25%) were between 31-40 years of age and 12 people (23.1%) were between >50 years of age (Figure 1,Table 2). The mean age of the patients was 44.04 +/- 9.40 years.

Figure 1: Showing age group distribution (in years).

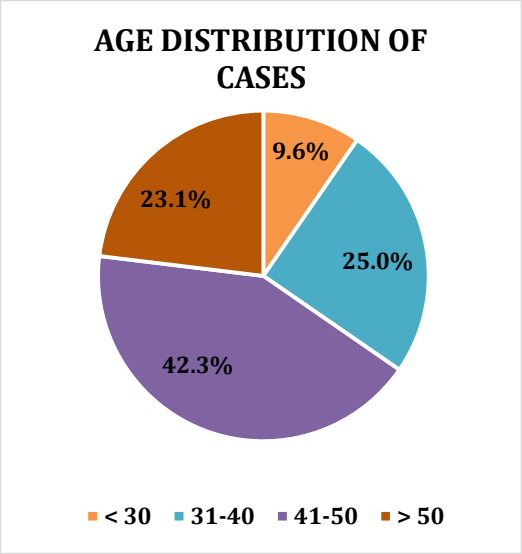


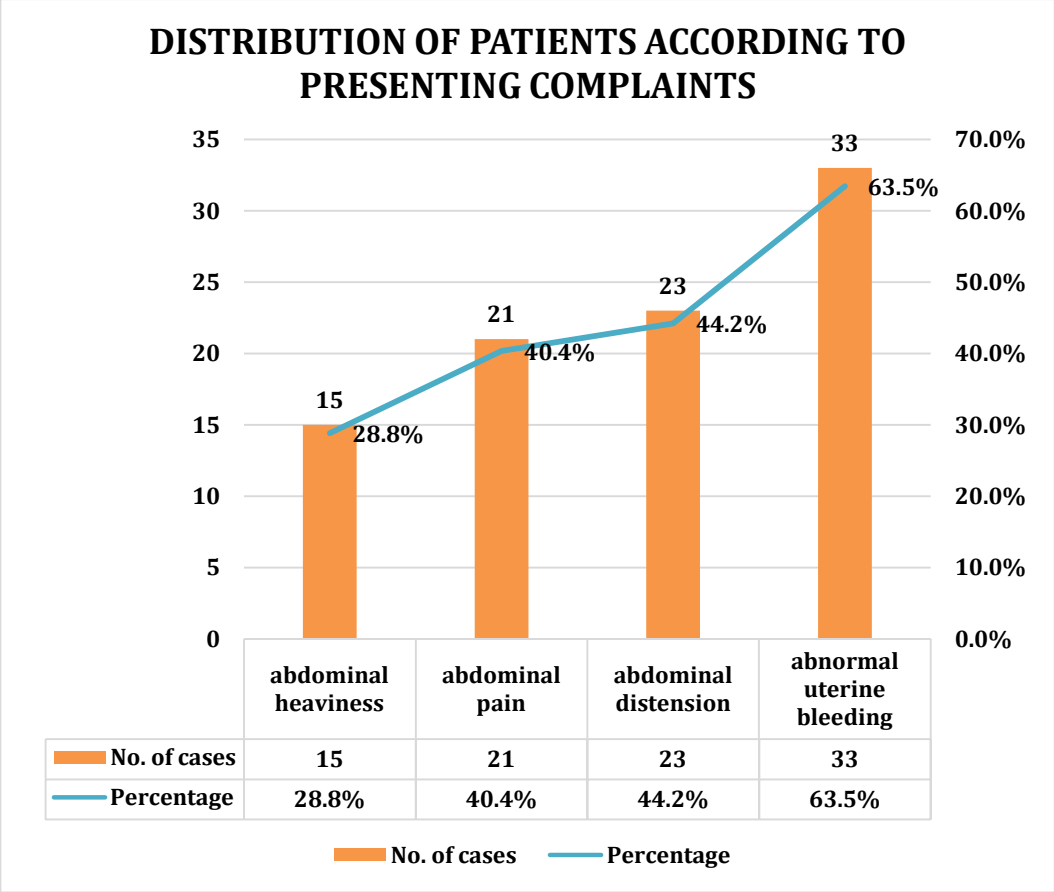
Table 2: Showing age group distribution (in years).

AGE GROUP	No. of cases	Percentage
< 30	5	9.6%
31-40	13	25.0%
41-50	22	42.3%
> 50	12	23.1%
Total	52	100.0%

B. PRESENTING COMPLAINTS OF PATIENTS

Most of the patients i.e. 33(63.5%) presented with abnormaluterine bleeding, while the second most common complaint was of abdominal distension which was seen in 23patients (44.2%). The distribution of the rest of the presenting complaints is displayed below (Figure 2)

Figure 2: Showing distribution of patients according to their presenting complaints.

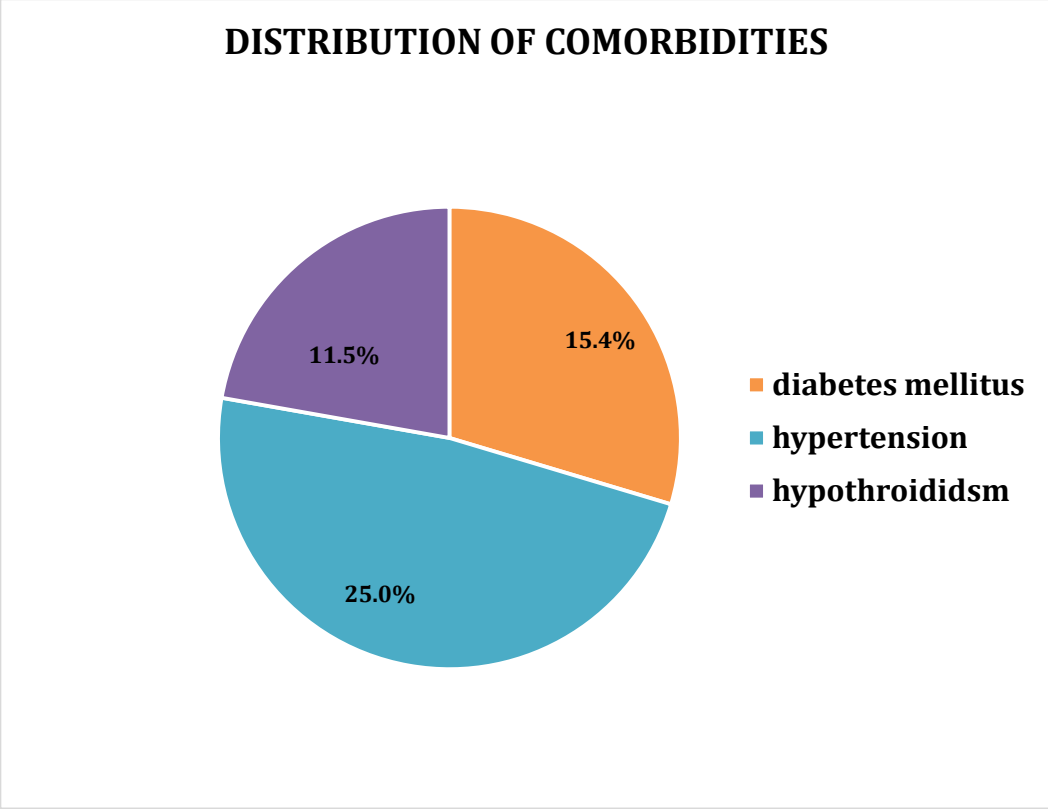


C. ASSOCIATED CO-MORBIDITIES OF THE PATIENTS

Out of the 52 patients included in present research study, 48.07% (n=25) had no relevant medical history, while 25%(n=13) were hypertensive, 11.5%(n=6) had a history of hypothyroidismand 15.4%(n=8) of the patients had a history of diabetes mellitus. (figure 3)

No relevant family history of cancer was observed in any of the patients in our study.

Figure 3: Showing distribution of the associated comorbidities.



D. BIOCHEMICAL ANALYSIS OF THE PATIENTS

In our present study, the mean value and standard deviation of Hb was 10.27+/- 2.39 gm/dl and the mean value and standard deviation of TLC was 8.55 +/-3.11 $x10^{-3}$ul. The results of the analysis of the various other biochemical parameters done on our subjects is listed below in the Figure 4 and Table 3.

Figure 4: Listing the various demographic details and biochemical parameters of the 52 patients in our study.

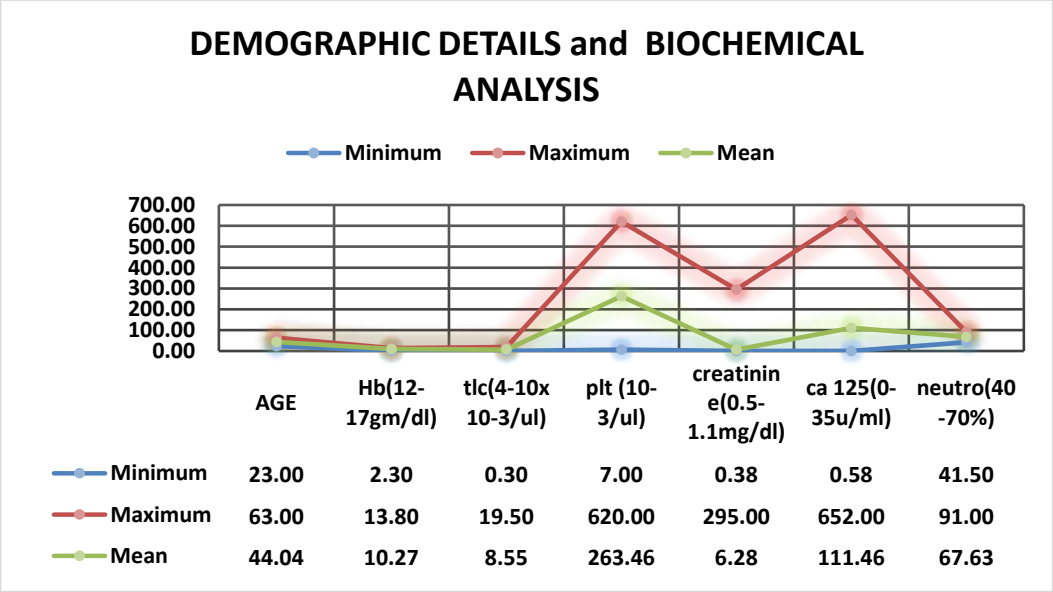


Table 3: listing the various demographic details and biochemical parameters of the 52 patients in our study.

VARIOUS CHARACTERISTICS	No	Minimum	Maximum	Mean	Std. Deviation
AGE	52	23.00	63.00	44.04	9.40
Hb(12-17gm/dl)	52	2.30	13.80	10.27	2.39
tlc(4-10x 10-3/ul)	52	0.30	19.50	8.55	3.11
plt (10-3/ul)	52	7.00	620.00	263.46	118.11
creatinine(0.5-1.1mg/dl)	52	0.38	295.00	6.28	40.82
ca 125(0-35u/ml)	9	0.58	652.00	111.46	206.89
neutro(40-70%)	51	41.50	91.00	67.63	11.41

E. PAP SMEAR EXAMINATION OF THE PATIENTS(wherever done)

Pap smear examination was done only in 20 (38.5%) out of the total 52 patients. It was negative for malignancy in all the patients who underwent the test. (**Table 4**).

Table 4: Showing distribution of pap smear based on number of cases.

pap smear(if done)	No. of cases	Percentage
not done	32	61.5%
negative for malignancy	20	38.5%
Total	52	100.0%

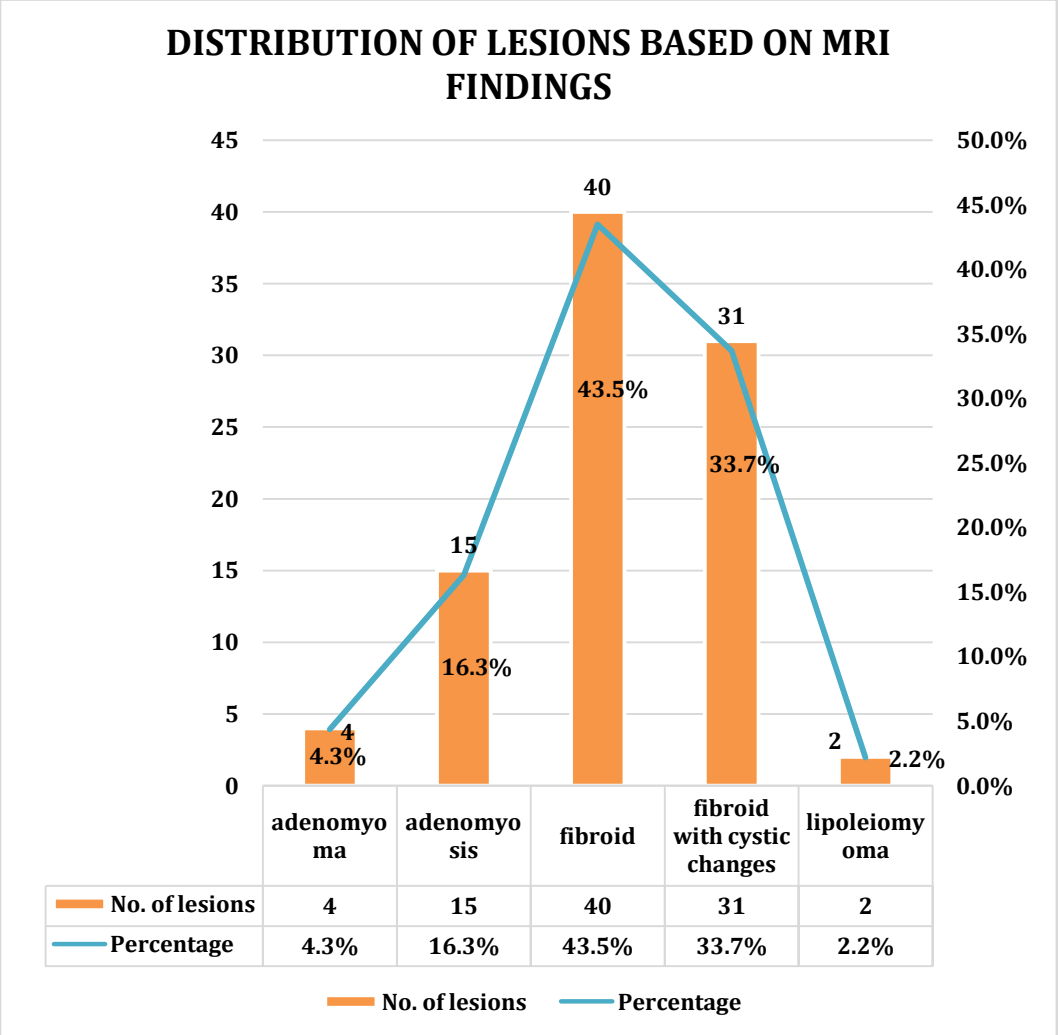
F. USG EXAMINATION

All the patients in our study underwent an USG examination prior to MRI imaging. 37 out of the 52 patients had an USG exam done in our department while the remaining 15 patients had undergone USG from outside.

G. MRI DIAGNOSIS

On the basis ofMRI, 92 lesions were identified. Majority of them i.e.40 (43.5%) lesions were diagnosed as fibroids, 31(33.7%) lesions were diagnosed as fibroids with cystic changes, 15 (16.3%) lesions were adenomyosis, 4 (4.3%) lesions were adenomyomas while 2(2.2%) lesions were lipoleiomyomas. (**Figure 5**).

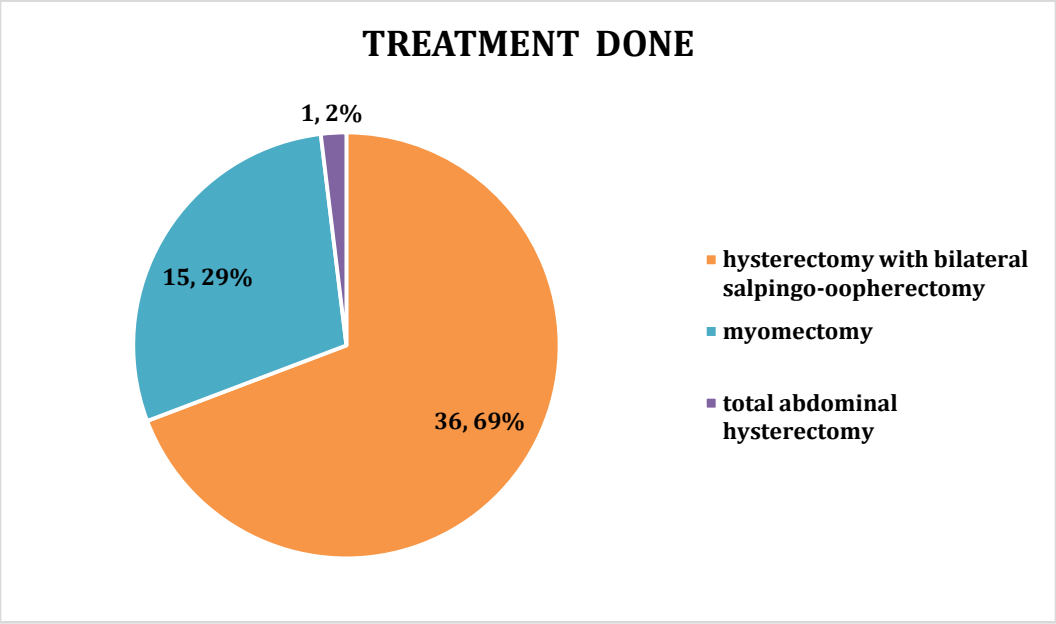
Figure 5: Showing distribution of MRI diagnosis.



H. TREATMENT PERFORMED

Various treatments were performed on the 52 patients. The majority of the patients i.e. 36(69%) underwent hysterectomy with bilateral salpingo-oopherectomy, while 15(29%) patients underwent myomectomy and only 1(2%) patient underwent total abdominal hysterectomy (Figure 6)

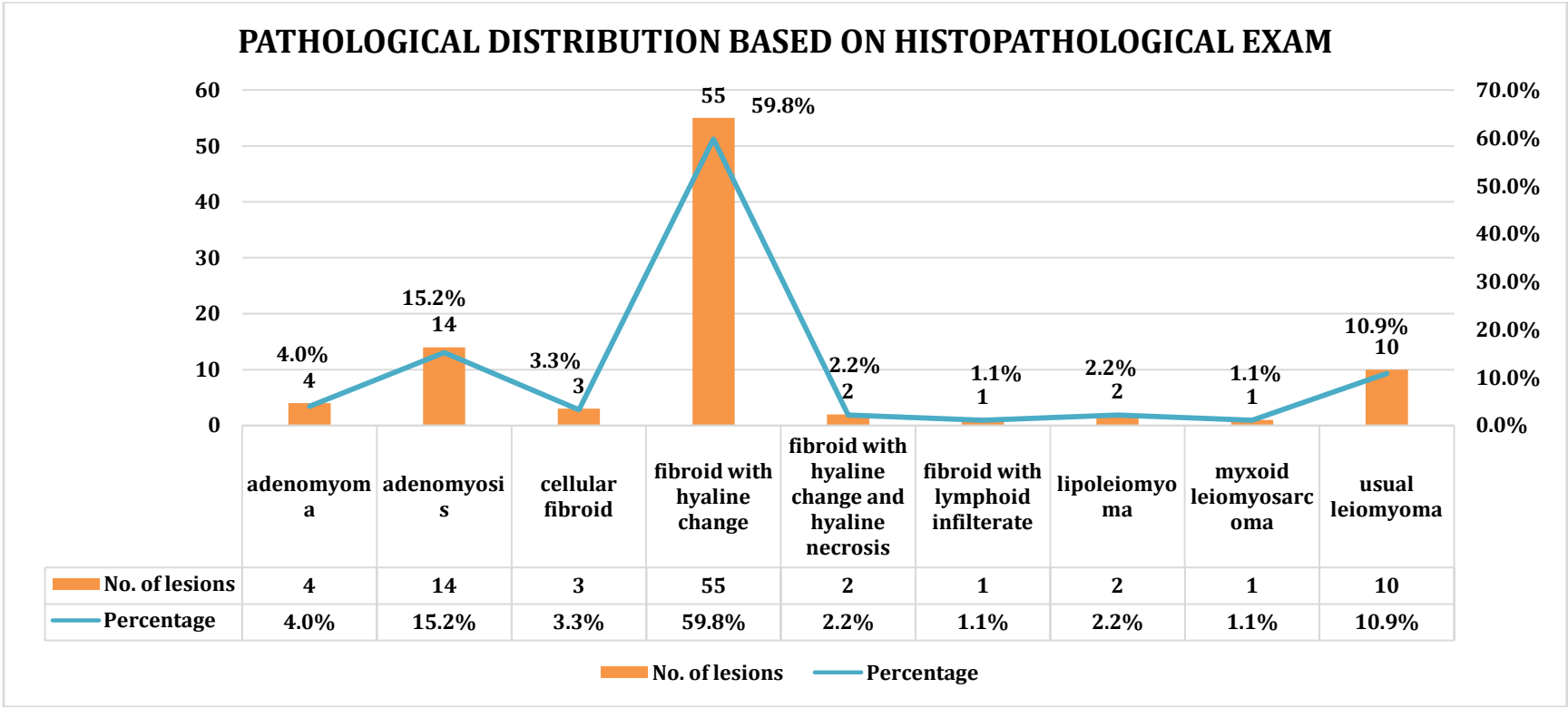
Figure 6: Showing the distribution of the treatments done on lesions.



I. HISTOPATHOLOGICAL ANALYSIS

Histopathological analysis was done on the lesions which was taken to be the gold standard for the final diagnosis of all the pathologies illustrated on imaging. It showed that maximum lesions were fibroids with hyaline change(n=55,59.8%), followed by adenomyosis(n=14,15.2%) and usual leiomyoma(n=10,10.9%). Only one lesion each was of fibroid with lymphoid infilterate and myxoid leiomyosarcoma. The distribution of all the various myometrial pathologies is listed in Figure 7.

Figure 7:Showing distribution of the histopathological results performed on the cases.



J. MRI IMAGING ANALYSIS

i. LOCATION OF THE LESIONS

On the basis of MRI analysis 66.3% (n=61) of the lesions were intramural, 20.7% (n=19) were subserosal, 8.7% (n=8) were submucosal and 4.3% (n=4) of the lesions had other locations and placement (**Figure 8 and Table 5**).

Figure 8: Showing myometrial distribution of the lesion on MRI.

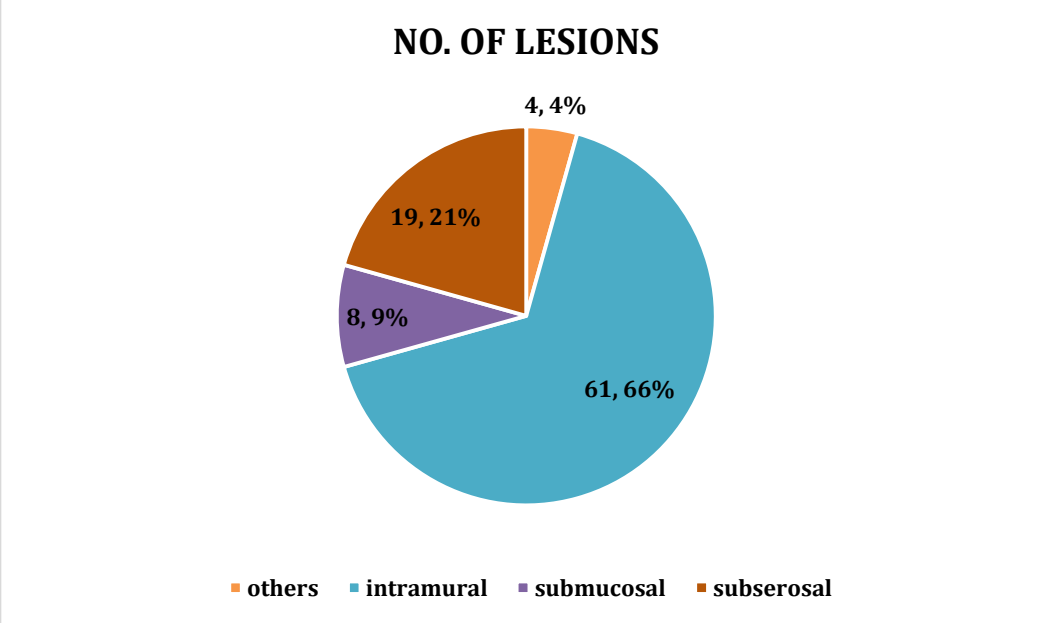


Table 5: Showing myometrial distribution of the lesion on MRI.

Myometrial location of lesions on MRI	No. of lesions	Percentage
others	4	4.3%
intramural	61	66.3%
submucosal	8	8.7%
subserosal	19	20.7%
Total	92	100.0%

The location of the 92 lesions on the myometrium based on observations made on MRI was that 38% (n=35) of the lesions were in the posterior myometrium, 32.6% (n=30) were in the anterior myometrium, 9.8% (n=9) were along the right lateral wall and 8.7% (n=8) of the lesions were along the left lateral wall. The remaining lesions 10.9% lesions had a varied spread as listed in the table 6 and shown in the figure 9 below.

Figure 9: Showing distribution of location of various lesions on MRI.

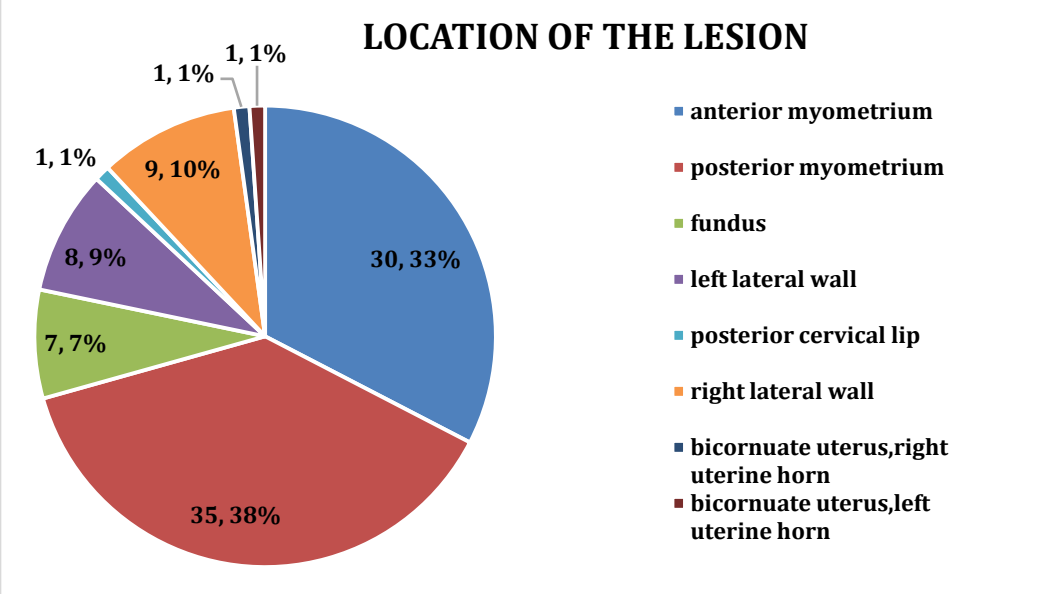


Table 6: Showing distribution of location of various lesions on MRI.

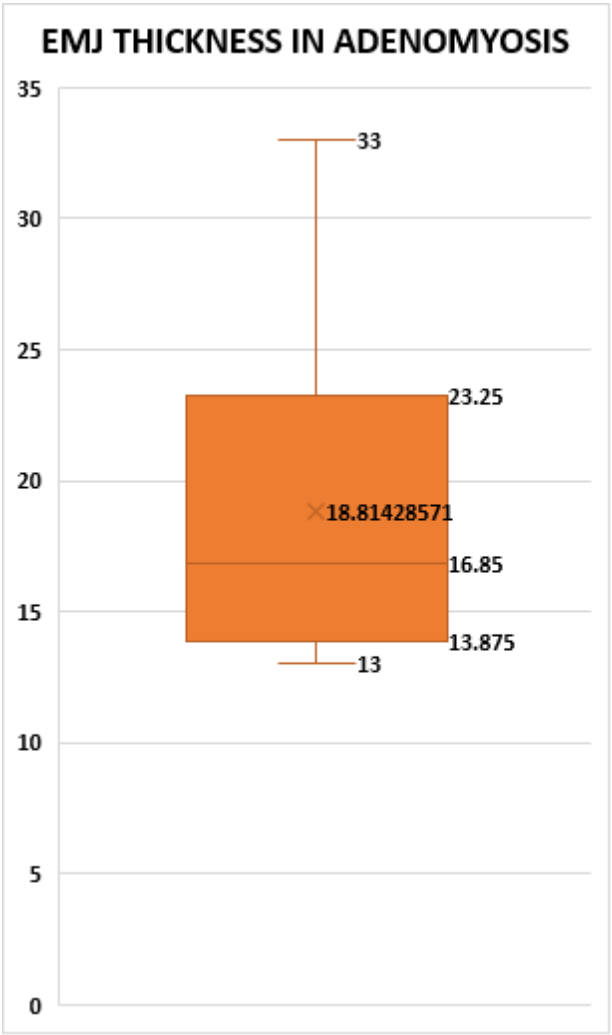
Location of lesion	No. of lesions	Percentage
anterior myometrium	30	32.6%
posterior myometrium	35	38.0%
fundus	7	7.6%
left lateral wall	8	8.7%
posterior cervical lip	1	1.1%
right lateral wall	9	9.8%
bicornuate uterus,right uterine horn	1	1.1%
bicornuate uterus, left uterine horn	1	1.1%
Total	92	100.0%

ii. EMJ THICKNESS FOR ADENOMYOSIS

The cut off for the diagnosis of adenomyosis based on the thickness of the endomyometrial junction was set at a predetermined value of 12mm based on the numerous previously conducted studies.

Out of the 15 total diagnosed cases of adenomyosis, the mean value and standard deviation of endomyometrial junction thickness came out to be 18.8+/-5.97mm (Figure 10).

Figure 10: Showed a box and whisker plot of the EMJ thickness in all the cases of adenomyosis.



iii. T1WI

T1WI hyperintensity was defined as the presence of any mass area with higher signal than fatty bone marrow of the pubis symphysis.

According to the signal intensity of the lesions on T1 weighted MRI sequence, 91.3% (84) lesions were isointense, 6.5% (6) were heterogeneously isointense, 1.1% (1) of the lesions were each hyperintense and hypointense respectively**(Figure 11 and Table 7)**.

Figure 11:Showing distribution of signal intensity of lesions on T1 weighted MRI sequence.

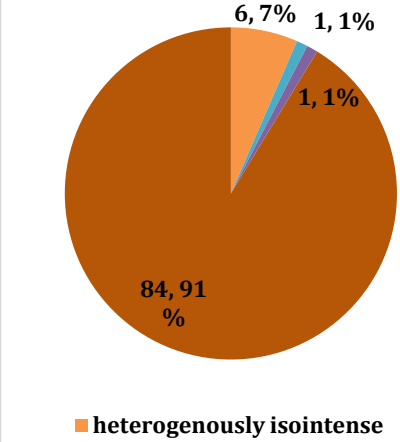


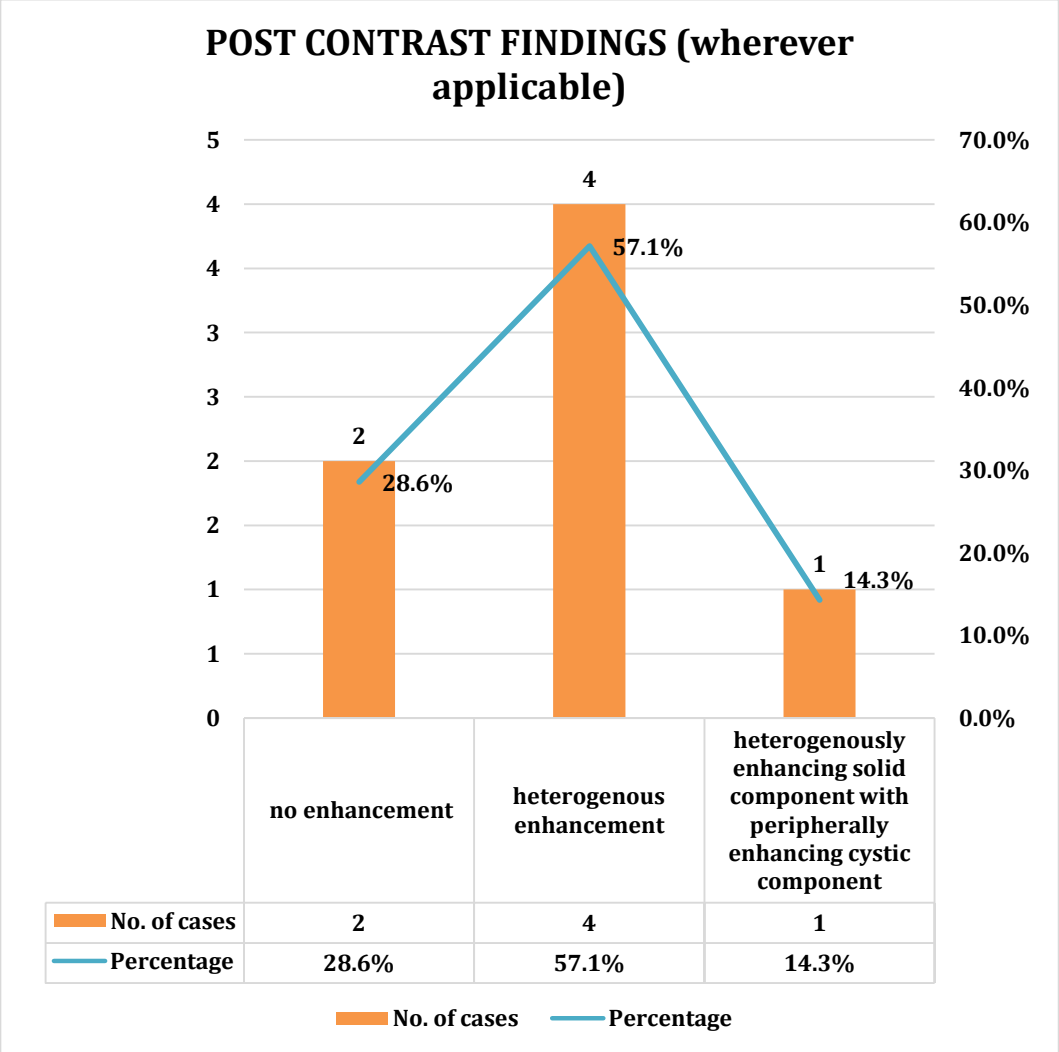
Table 7:Showing distribution of signal intensity of lesions T1 weighted MRI sequence.

SI ON t1	No. of lesions	Percentage
heterogenously isointense	6	6.5%
hyperintense	1	1.1%
hypointense	1	1.1%
isointense	84	91.3%
Total	92	100.0%

iv. T1 POST CONTRAST (wherever applicable)

Contrast was administered in only 7.6%(n=7) of the total cases out of which 71.4%(n=5) showed heterogenous enhancement. The distribution of contrast findings on MRI in the cases where contrast was administered is represented in figure 12.

Figure 12: Showing distribution of postcontrast findings on MRI in the lesions where contrast was administered.

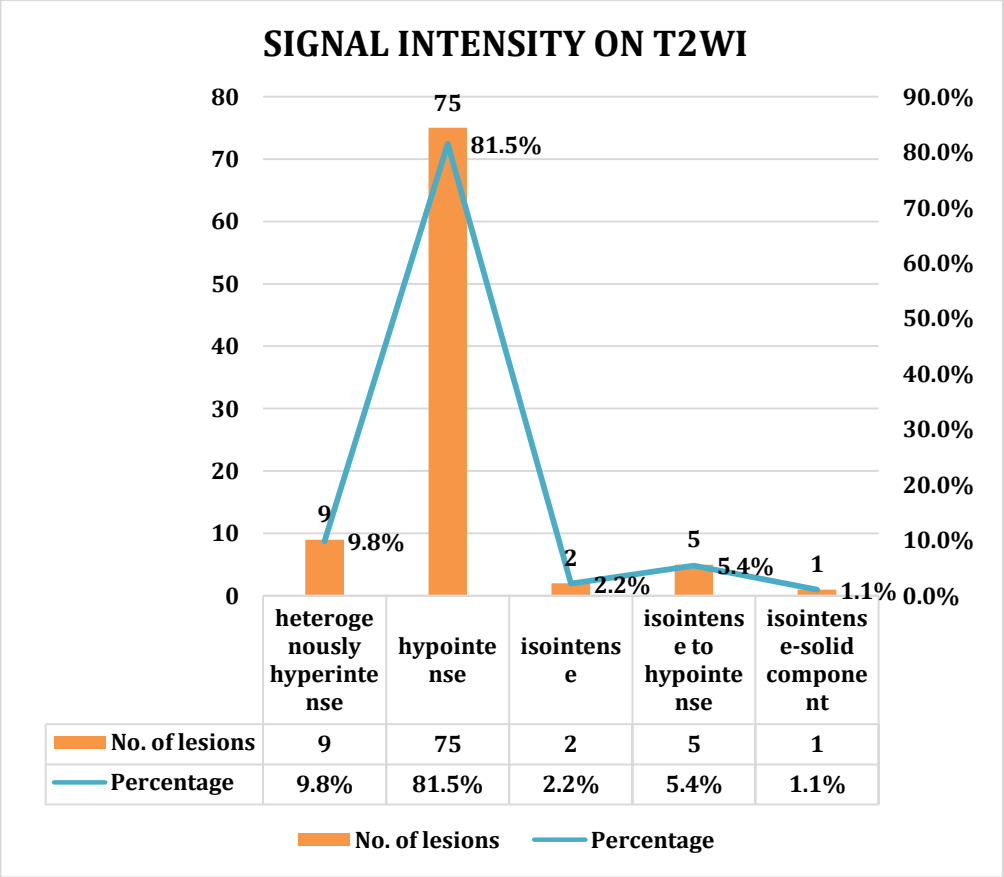


v. T2WI

The normal anatomy of the uterus and junctional zone is well seen on T2-weighted images with the normal uterus demonstrating the hyperintense endometrium, lower signal of the inner myometrium or junctional zone, and intermediate signal of the outer myometrium. T2WI hyperintensity was defined as more than half of the mass with signal higher than that of the outer myometrium on T2 weighted imaging MRI sequence

According to the signal intensity of the lesions on T2 WI, the maximum number of the lesions were hypointense i.e.75 lesions (81.5%). 2 lesions (2.2%) were isointense, 1 of the lesions (1.1%) was solid cystic in nature and demonstrated an isointense solid component, 9 lesions(9.8%) were heterogeneously hypointense while 5 lesions (5.4%) demonstrated isointense to hypointense signal (**Figure 13**).

Figure 13: Showing distribution of signal intensity of lesions on T2 weighted MRI sequence.



viii. DWI

DWI performed in the normal uterus shows high signal in the endometrium and cervix, whereas the myometrium is typically of relatively low signal and the junctional zone demonstrates even lower signal. DWI positivity was deemed when the lesion illustrated bright signal on high b-value(b value 1000 s/mm^2) with a lower signal on T2 with/without a corresponding low signal on ADC maps.

Out of the total 92 lesions only 8(8.7%) showed diffusion restriction (Figure 14 and Table 8). The diffusion restriction lesions comprised of all the 3 cellular fibroids , 3 fibroids with hyaline change , 1 fibroid with lymphoid infilterate and 1 adenomyoma(Figure 19)

Figure 14: Showing distribution of DWI (diffusion weighted imaging) on MRI.

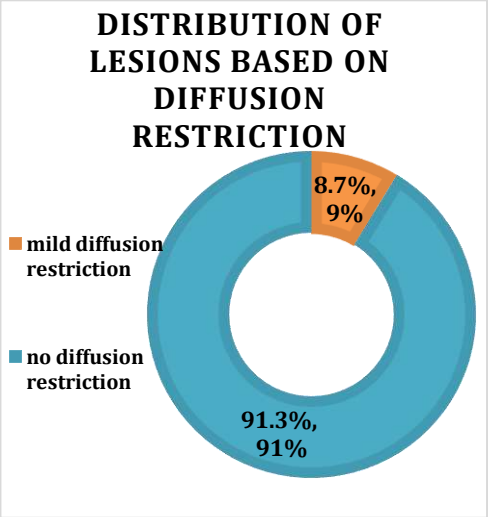
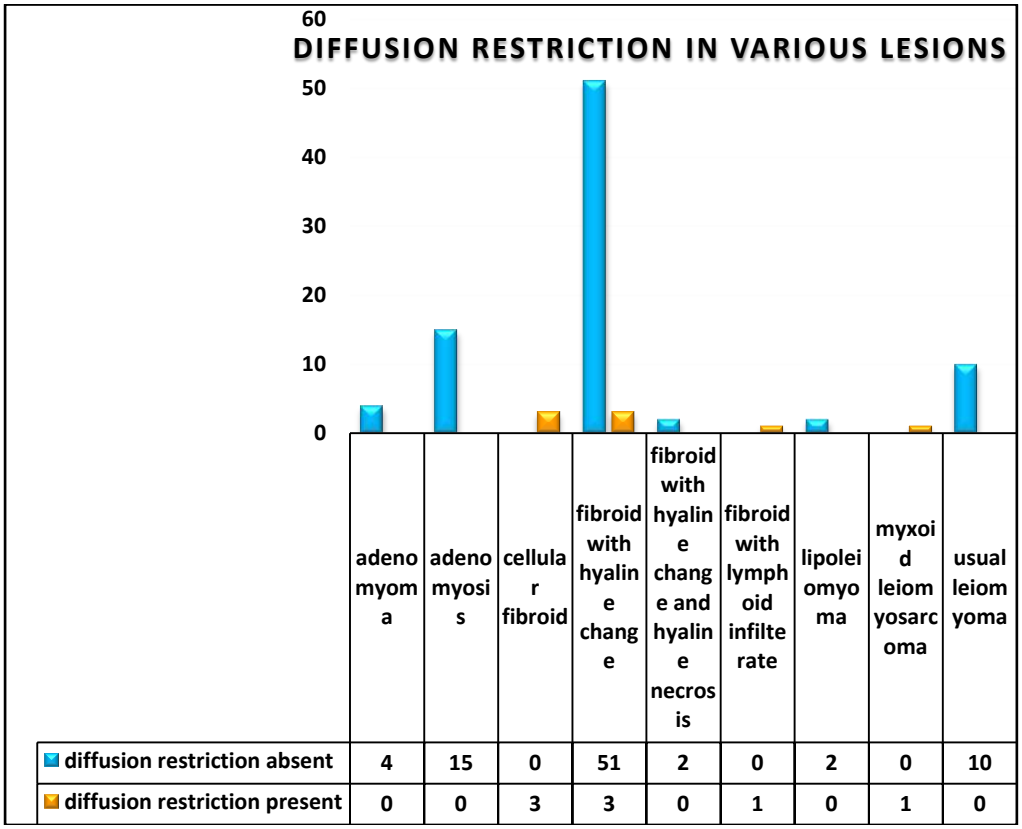


Table 8: Showing distribution of DWI (diffusion weighted imaging) on MRI.

DWI on mri	No. of lesions	Percentage
mild diffusion restriction	8	8.7%
no diffusion restriction	84	91.3%
Total	92	100.0%

Figure 15: Showing distribution of DWI based on the histopathological diagnosis.



	adenomyoma	adenomyosis	cellular fibroid	fibroid with hyaline change	fibroid with hyaline change and hyaline necrosis	fibroid with lymphoid infiltrate	lipoleiomyoma	myxoid leiomyosarcoma	usual leiomyoma
diffusion restriction absent	4	15	0	51	2	0	2	0	10
diffusion restriction present	0	0	3	3	0	1	0	1	0

ix. ADC values

The ADC values of each of the lesions was calculated using the methods listed in the materials and methods section of our study. The enumerated values were then correlated to the resultant findings obtained on histopathological analysis. The ADC values were calculated in both the lesions and in the areas of the normal myometrium seen within the same patient.

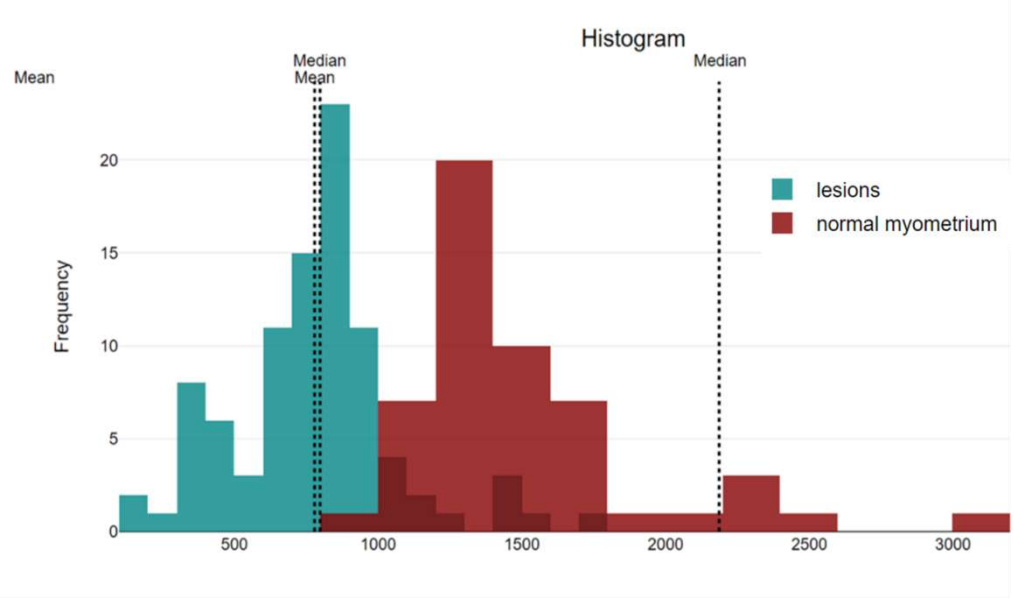
The mean ADC value +/- sd of the normal myometrium in our patients was 1493 +/- 392.48 $x10^{-6}$ mm^2/s with a 95% confidence interval and the mean ADC values of pathological myometrium (mean ADC value of all the myometrial lesions) was 783.5 ± 293.42 x 10^{-6} mm^2 /s with a 95% confidence interval (Table 9).

Table 9: Mean and standard deviation of the ADC values of normal myometrium and of lesions.

ADC values (10^{-6} mm^2 /s)	Mean	Median	Modal	Std. Deviation	Min-imum	Max-imum	Range	Skew	Number of valid values	95% Confidence interval of Mean	Mean ± Std.
lesions	778.83	798	633	288.41	149	1,745	1,596	0.5	92	719.89-837.76	778.83 ± 288.41
myometrium	1493	1359	1311	392.48	975	3,003	2,028	1.84	52	1386.32-1,599.68	1493 ± 392.48

A histogram representing the distribution of the ADC valuesof normal myometrium and pathological myometrium is illustrate below in Figure 16.

Figure 16: Representing the distribution curve of the ADC values in pathologicalmyometrium and in normal myometrium.



The diagnostic ability of a cut-off ADC value to discriminate diseased myometrium from normal myometrium was evaluated using the Receiver Operating Characteristic (ROC) curve analysis. TheROC curve was plottedbetween the true positive rate (Sensitivity) in function of the false positive rate (100-Specificity) for different probable cut-off points of ADC values.

According to ROC curve coordinates, a cut-off value of ≤1007 x10^{-6} mm^2/s produced 88.04% sensitivity and 98.91%specificity, whereas a cut-off value of ≤1147x10^{-6} mm^2/s produced 91.3%sensitivity and 90.2% specificity in differentiating pathological from normal myometrium. (figure 17, table10)

Figure 17: Sensitivity and specificity ROC curves.

A cut-off value of ≤1007 x10^{-6} mm^2/s produced 88.04% sensitivity and 98.91%specificity, whereas a cut-off value of ≤1147 produced 91.3% sensitivity and 90.2% specificity in differentiating pathological from normal myometrium.

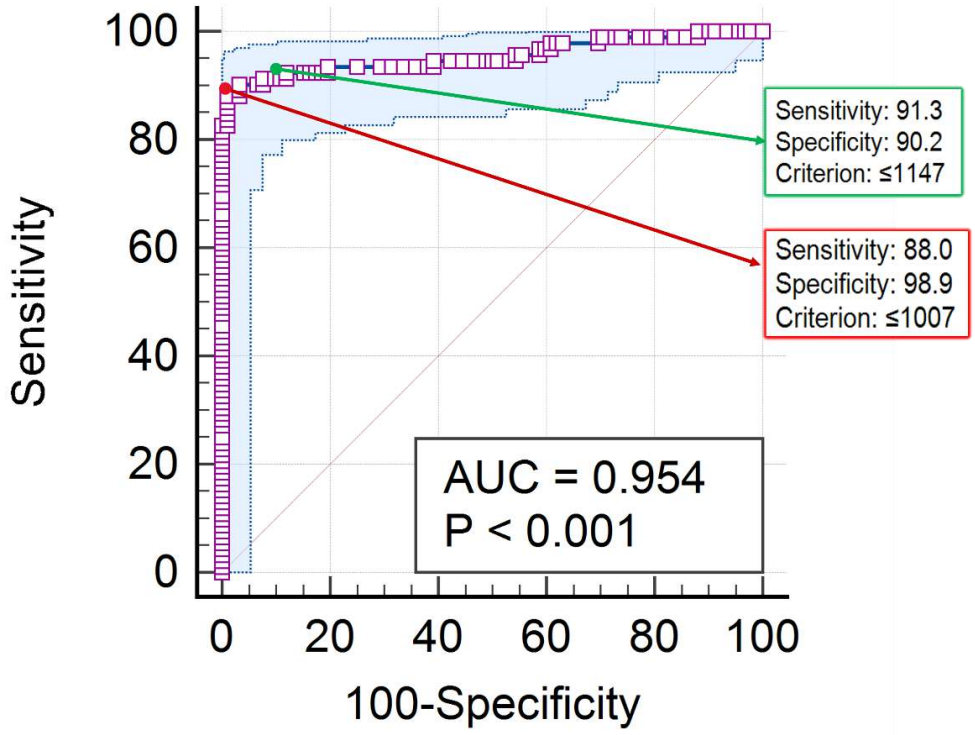


Table 10: Showing the sensitivity and specificity of the two comparable ADC cut-off values.

ADC cut off (x10^{-6} mm^2/s)	≤1007	≤1147
Sensitivity	88.04%	91.3%
Specificity	98.91%	90.2%

The Area Under the ROC curve (AUC) was plotted to determine the efficacy of ADC value to differentiate pathological and normal myometrium which yielded favourable results with an AUC of 0.95 (95% Confidence interval0.913 to 0.979 and a p<0.0001).(Table 11)

Table 11: Showing the AOC, standard error, 95% CI obtained from the ROC analysis.

Area under the ROC curve (AUC)	0.954
Standard Error	0.0169
95% Confidence interval	0.913 to 0.979
z statistic	26.833
Significance level P (Area=0.5)	<0.0001

From the findings of ROC and AUC, a max. cut off ADC value of ≤1007 $x10^{-6}$ mm^2/swas established which produced 88.04% sensitivity and 98.91%specificity.This was the max. amount of both sensitivity and specificity that could be achieved by any ADC cut off value in our study.

On the basis of histopathological examination the ADC values determined for each lesion during MRI were analysed and interpreted.

The mean ADC values +/- standard deviation (in $x10^{-6}$ mm^2/s) of the individual pathologies was found to be as follows:

- $1489x10^{-6}$ mm^2 /s in lipoleiomyoma
- 1004 $x10^{-6}$ mm^2 /s in fibroid with lymphoid infilterate
- 875 $x10^{-6}$ mm^2/s in myxoid leiomyosarcoma
- 865.13+/-195.93 $x10^{-6}$ mm^2/s in adenomyosis
- 823.00 +/- 73.6 $x10^{-6}$ mm^2/s in adenomyoma
- 759.00 +/ 209.30 $x10^{-6}$ mm^2/s in fibroid with hyaline change & necrosis
- 757.43 +/- 275.75 $x10^{-6}$ mm^2/s in fibroid with hyaline change,
- 681.10 +/- 365.74 $x10^{-6}$ mm^2/s in usual leiomyoma
- 431.7 +/-174.4 $x10^{-6}$ mm^2/s in Cellular fibroid.

Figure 18: Showing the mean ADC values and the standard deviation of the various myometrial pathologies arranged in ascending order.

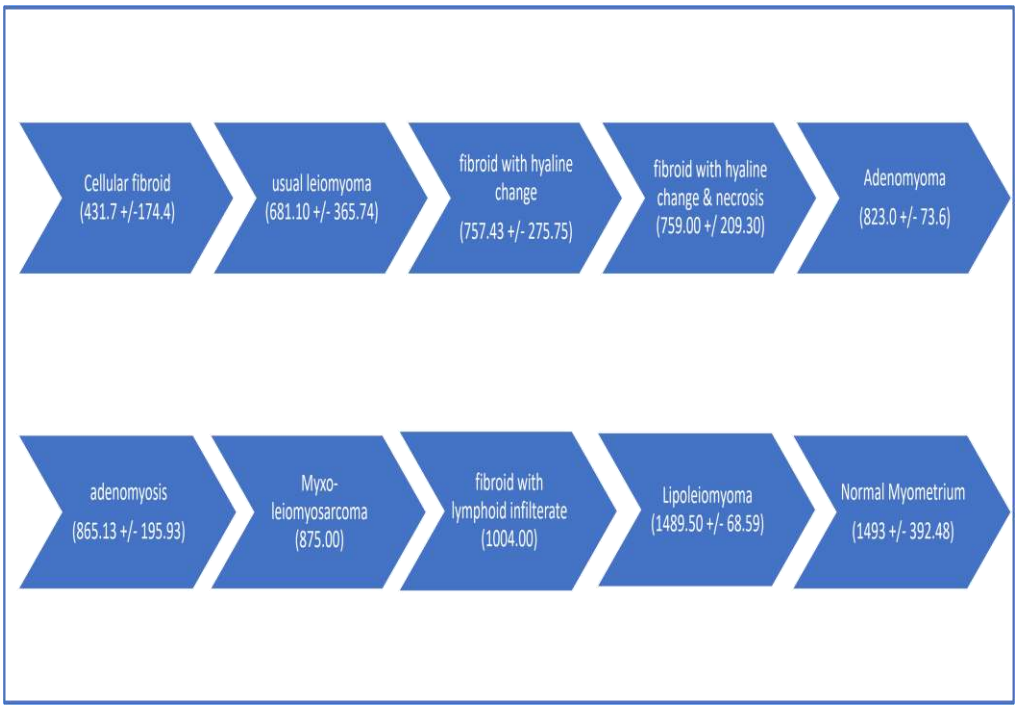
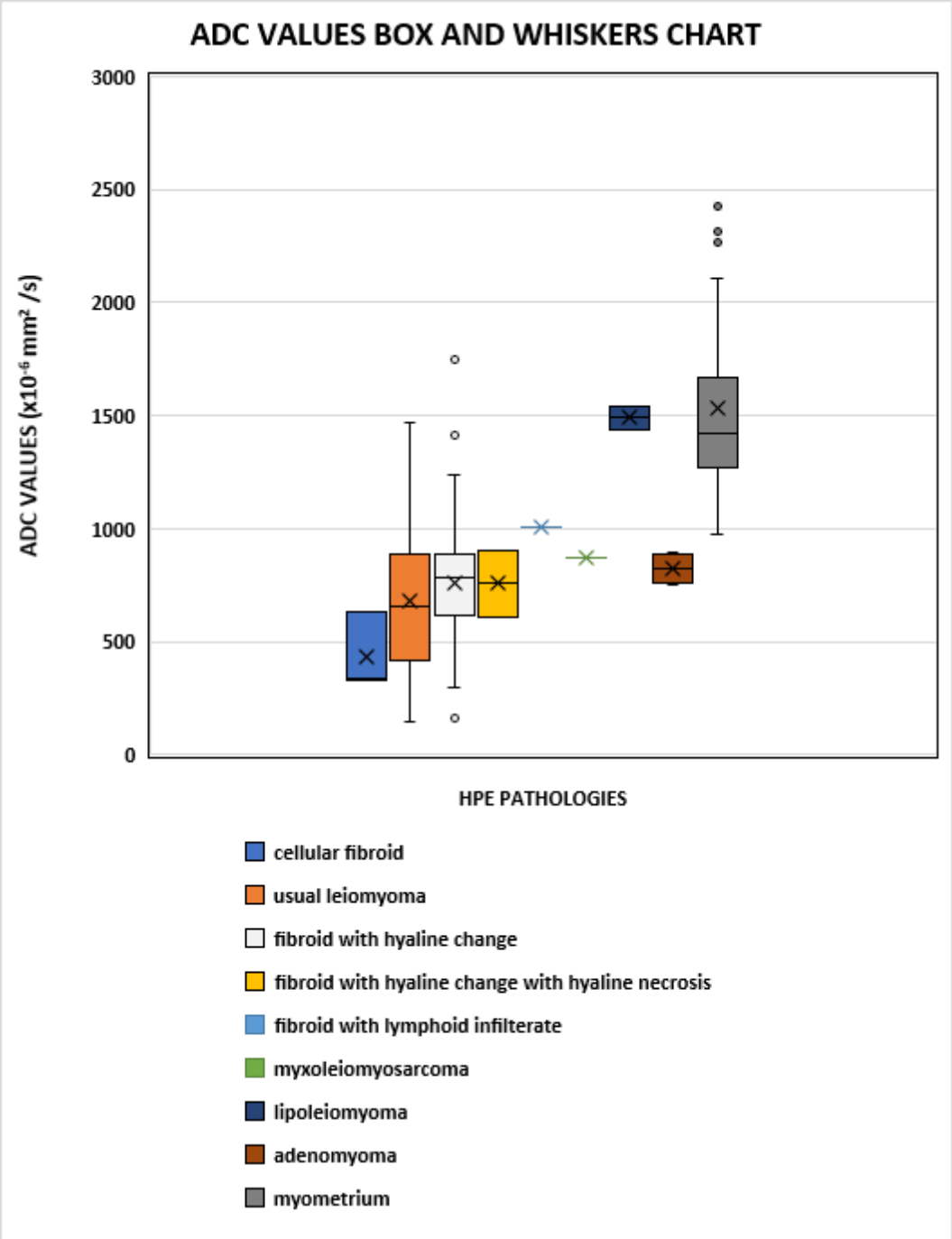


Table 12: Showing the mean, standard deviation and 95% CI of ADC values of the various myometrial pathologies.

		ADC VALUES OF LESIONS								
	N	MEAN	STD. DEVIATION	STD. ERROR	95% CONFIDENCE INTERVAL FOR MEAN		MINIMUM	MAXIMUM	F	P-VALUE
HPE DIAGNOSIS					Lower Bound	Upper Bound				
adenomyoma	4	823.00	73.67	36.84	750.8	895.2	755.00	894.00	3.409	0.002
adenomyosis	15	865.13	195.93	50.59	765.98	964.29	309.00	1189.00		
cellular fibroid	3	431.67	174.39	100.68	234.33	629	328.00	633.00		
fibroid with hyaline change	54	757.43	275.75	37.53	683.88	830.98	163.00	1745.00		
fibroid with hyaline change and hyaline necrosis	2	759.00	209.30	148.00	468.92	1049.08	611.00	907.00		
Fibroidwith lymphoid infilterate	1	1004.00	.	.	.	.	1004.00	1004.00		
lipoleiomyoma	2	1489.50	68.59	48.50	1394.44	1584.56	1441.00	1538.00		
myxoid leiomyosarcoma	1	875.00	.	.	.	.	875.00	875.00		
usual leiomyoma	10	681.10	365.74	115.66	454.41	907.79	149.00	1471.00		
Total	92	783.50	293.42	30.59	723.54	843.46	149.00	1745.00		

Figure 19: Showing a box and whisker plot of the ADC values of all the lesions.



DISCUSSION

Myometrial pathologies are gynaecological ailments commonly occurring in females after the third decade of life.

Diffusion-weighted imaging (DWI) is an essential MRI technique in evaluating the female pelvis, routinely used to identify and potentially characterize both benign and malignant gynaecologic diseases. Initially, the DWI technique was used in brain imaging, especially to detect a small and early acute ischemic stroke. Currently, DWI is widely used in abdominal imaging.

DWI (diffusion-weighted imaging) which is based on the principle of Brownian motion has helped in better delineation and characterisation of the various pathologies in human body including various gynaecological diseases and can reveal an abnormal signal pattern in pathologic areas. The quantitative parameter acquired from the DWI sequence is the apparent diffusion coefficient (ADC value). In the last few decades, the advent of parallel imaging and rapid data acquisition has significantly improved the quality of the DWI technique. This has made its use possible in several clinical applications, providing high-quality exams with a better signal-to-noise ratio (SNR) without significantly increasing the total scan time duration.[4,6,100-103]

It has been stated in prior studies that the ADC values may be distinct in myometrial pathologies and help in better diagnosis and treatment planning especially in predicting the response of benign myometrial pathologies like fibroids and adenomyosis to uterine artery embolization. **Lee D et al., (2013)**[61] did a study on 72 uterine leiomyomas where the ADC ranged from 0.559 $\times 10^{-3}$ mm^2/s to 1.814 $\times 10^{-3}$ mm^2/s (mean, 1.170 $\times 10^{-3}$ mm^2/s). The ADC value of lesions was significantly related to the volumetric response of leiomyomas (P = .014). Using a threshold of 1.092 $\times 10^{-3}$ mm^2/s, the sensitivity and specificity of ADC for prediction of > 50% volume reduction of the leiomyoma after UAE were 82.6% and 52.3%, respectively. Using a threshold of 1.023 $\times 10^{-3}$ mm^2/s, the sensitivity and

specificity of ADC for prediction of < 30% volume reduction were 80.8% and 33.3%, respectively.In the study done by **Park Y et al., (2013)**[104] on the 23adenomyosis, 17 showed complete response and 6 showed an incomplete response to UAE. The ADC ranged from 0.8413±1.2440 x 10^{-3}mm²/s (mean 1.0745 ± 0.1122 x 10^{-3}mm²/s). The mean ADC of the complete response group was 1.0449 ± 0.1063 x 10^{-3}mm²/s and 1.1585 ± 0.0881 x 10^{-3}mm²/s in the incomplete response group (p-value = 0.029). Using a threshold of lesser than 1.1475 x 10^{-3}mm²/s, the sensitivity, and specificity of the ADC for the prediction of success after UAE were 83.3% and 82.4%, respectively.

It was assumed that ADC values may be distinct in myometrial pathologies and help in better diagnosis and treatment planning especially in predicting the response of benign myometrial pathologies like fibroids and adenomyosis to uterine artery embolization. The current study was undertaken to see the utility of diffusion and ADC maps in characterisation of the various myometrial pathologies. The areas of normal myometrium within the patients was taken as the internal standard.Qualitative as well as quantitative analysis of signal intensities was done to evaluate the variation in mean values to derive feasible cut off values that would help in the accurate pretreatment diagnosis of various myometrial pathologies.

Demographic data and Presenting complaints

We did a prospective study on 52 patients for a duration of one year between March 2021 and February 2022. The patients in our study were between the age group of 18 to 60 years and presented to us with a variety of pelvic symptoms. The maximum number of patients in the present study i.e. 22 people (42.3%) were between 41-50 years of age while 13 people (25%) were between 31-40 years of age and 12 people (23.1%) were between >50 years of age.The mean age of the patients in our study was 44.04 +/- 9.40 years.

This was in agreement with a previousstudy done by **Bader S.J. et al. (2017)**[91] wherein 51.8% of the subjects were between 45 years and more

of age, 33.9% were between 35-44 years and 14.3% were between 25 - 34 years.

In a study done by **Abdel Wahab C et al. (2020)**[95] , wherein DWI was performed on 137 of 156 women demonstrated that the women with sarcomas were older than women with leiomyomas (median age, 64 years vs 48 years [interquartile range, 53–72 years], respectively; P >0 .001). This was in agreement with our study.

Most of the patients i.e.33(63.5%) patients presented with abnormal uterine bleeding, while the second most common complaint was of abdominal distension which was seen in 23patients (44.2%). Other complaints were abdominal pain seen in 21patients (40.4%) and abdominal heaviness seen in 15 patients(28.8%).

The presenting complaints of the patients in the study done by **Ahmed SE et al.(2022)**[98] were similar to those in our study with the most common clinical symptom being irregular uterine bleeding and pelvic pain which occurred in about 29.41% of the patients.

In the study by **Bader S.J. et al.(2017)**[91] the most likely presentation was dysmenorrhea and abnormal uterine bleeding which was similar to the presenting complaints seen in our study.

Associated co-morbidities of the patients

Out of 52 patients included in the present research, 48.07% (n=25) had no relevant medical history, while 25% were hypertensive (n=13), 11.5% had a history of hypothyroidism (n=6) and 15.4% of the patients had a history of diabetes mellitus (n=8). No relevant family history of cancer was observed in all the patients.

Ina study done by **Bader S.J.et al.(2017)**[91],60.7% of study samples had negative medical history while 8.9% had diabetes mellitus and 30.4% had hypertension. These comorbid complaints were in accordance to those found in our study.

Spectrum of pathologic lesions

On the basis of MRI, 92 lesions were identified. Majority of them i.e.40 (43.5%) lesions were diagnosed as fibroids, 31(33.7%) lesions were diagnosed as fibroids with cystic changes, 15(16.3%) lesions were adenomyosis, 4(4.3%) lesions were adenomyomas while 2(2.2%) lesions were lipoleiomyomas.

The histopathological analysis, which was taken to be the gold standard for the final diagnosis of all the pathologies illustrated that the maximum lesions were fibroids with hyaline change (n=55,59.8%), followed by adenomyosis (n=14,15.2%) and usual leiomyoma (n=10,10.9%). There was only one lesion each of fibroid with lymphoid infilterate(1.1%) and myxoid leiomyosarcoma(1.1%) in our study. The other lesions that were obtained in our study were 4 adenomyomas (4%), 3 cellular fibroids (3.3%), 2 lipoleiomyomas (2.2%) and 2 fibroid with hyaline change and hyaline necrosis (2.2%) were identified in our study.

The total number of patients in the study by **Bader S.J. et al.(2017)**[91] were 56. 25 out of them were diagnosed as uterine fibroids and 31 as adenomyosis. This was in accordance to the findings in our study.

In the study done by **Lin G et al., (2016),**[100] total 33 patients were eligible for final analysis, with final histopathologic diagnosis as LMS in 6 patients, STUMP in 2 patients and benign leiomyoma in 25 patients. Out of the benign leiomyomas, 3 were cellular leiomyoma, 3 were infracted leiomyoma, 8 were degenerated leiomyoma and 11 were ordinary leiomyomas.

In a study done by **Himoto Y et al., (2021)**[102] in the low-grade endometrial stromal sarcoma (LGESS) group, a malignant tumor was suspected before treatment in 15 cases (60%; sarcoma, n = 14; endometrial cancer, n = 1), whereas benign disease was presumed preoperatively in ten cases (40%; leiomyoma, n = 9; adenomyosis, n = 1). The Rare leiomyoma variant group included 25 cases of cellular leiomyoma (preoperative diagnosis: leiomyoma, n = 15; degenerated

leiomyoma, n = 6; adenomatoid tumor, n = 1; sarcoma, n = 2; cervical cancer, n = 1), nine cases of leiomyomas with bizarre nuclei (preoperative diagnosis: leiomyoma, n = 8; degenerated leiomyoma, n = 1), two cases of atypical leiomyoma (preoperative diagnosis: leiomyoma, n = 2), four cases of mitotically active leiomyoma (preoperative diagnosis: leiomyoma, n = 2; cellular leiomyoma, n = 1; sarcoma, n = 1), and two cases of intravenous leiomyomatosis (preoperative diagnosis: intravenous leiomyomatosis, n = 2).These findings were largely similar to those seen in our study.

Imaging analysis

T1WI hyperintensity was defined as the presence of any mass area with higher signal than fatty bone marrow of the pubis symphysis.

According to the signal intensity of the lesions on T1 weighted MRI sequence, 91.3% (84) lesions were isointense, 6.5% (6) were heterogeneously isointense, 1.1% (1) of the lesions were each hyperintense and hypointense respectively**.**

The normal anatomy of the uterus and junctional zone is well seen on T2-weighted images with the normal uterus demonstrating the hyperintense endometrium, lower signal of the inner myometrium or junctional zone, and intermediate signal of the outer myometrium. T2WI hyperintensity was defined as more than half of the mass with signal higher than that of the outer myometrium on T2weighted imaging MRI sequence

According to the signal intensity of the lesions on T2 WI, the maximum number of the lesions were hypointense i.e.75 lesions (81.5%). 2 lesions (2.2%) were isointense, 1 of the lesions (1.1%) was solid cystic in nature and demonstrated an isointense solid component, 9 lesions (9.8%) were heterogeneously hypointense while 5 lesions (5.4%) demonstrated isointense to hypointense signal.

i. DWI

DWI positivity was deemed as more than 50% signal higher than that of the outer myometrium on high b-value DWI (b value- 1000 s/mm^2) and a

lower signal on ADC maps. Out of the total 92 lesions, only 8(8.7%) showed diffusion restriction.

Hyperintensity on DWI yielded a high sensitivity but limited specificity. All the lesions that were cellular fibroids showed diffusion restriction due to the increased cellularity of cells within the lesion. However, some lesions (n=3)of fibroid with hyaline change, one lesion of fibroid with lymphoid infiltrates, and 1 adenomyoma also demonstrated mild diffusion restriction. Hence, DWI as a lone parameter has little significance in terms of accurately determining the nature of the lesion.

Cellular fibroids are close differentials of low-grade stromal sarcomas on conventional imaging. So, in these cases, DWI/ADC coupled with conventional sequences is a novel technique used for their differentiation. While on the other hand, high-grade stromal sarcomas have a pathologically different appearance on conventional imaging, hence DWI /ADC acquisition is not necessary.

The study done by **Lin G et al., (2016),**[92] a combination of DWI and ADC cut off value of 1.08 $\times 10^{-3}$ mm^2/s yielded a diagnostic performance as high as that of CE-MRI and with resultant diagnostic accuracy, sensitivity, and specificity of 0.88, 0.88, and 0.88respectively in differentiating LMS/STUMP (ADC values-median 0.89×10^{-3} mm^2/s, range $0.74–1.85\times10^{-3}$ mm^2/s) from leiomyomas (ADC values- median 1.19×10^{-3} mm^2/s, range $0.70–2.04\times10^{-3}$ mm^2/s, $P < 0.05$, Mann–Whitney U test).These findings are not in accordance to our study. The difference may be due to differential cellular milleu in the fibroids which was not distinguished in this study.

ii. ADC values

NORMAL MYOMETRIUM

The mean ADC of all the lesions was 778.83+/-$x10^{-6}$ mm^2 /s and for the normal myometrium was 1493 +/- 392.48 $x10^{-6}$ mm^2 /s with a 95% confidence interval.

A maximum cut-off ADC value of 1007 $x10^{-6}$ mm^2 /s was taken to differentiate between pathological myometrium and normal myometrium. The sensitivity obtained was 88.04% and the specificity was 98.91%.

According to **Liapi et al.**[5] the normal myometrium had a mean ADC value of 2050 $x10^{-6}$ mm^2 /s. This value is higher than ADC values that were found in our study. The difference may be due to differential experimental settings, including the hardware facilities and technical parameters.

The study done by **Erdem et al., (2007)**[6] was in accordance with our study where in the adjacent myometrial tissue in patients with leiomyomas had ADC values of 1082 to 2330 $x10^{-6}$ mm^2 /s (mean 1684.4, SD: 366.1) and the normal myometrial tissue in the control group had ADC values of 1146 to 2528 $x10^{-6}$ mm^2 /s (mean: 1660.6, SD: 335.2).

Tamai et al.[23] stated that the mean ADC value for normal myometrium was found to be 1620 $x10^{-6}$ mm^2 /s. This value is almost identical with our results.

The study done by **Jha RC et al., (2014)**[27] was in accordance with our study. It showed that the mean and the standard deviation of the ADC value of myometrium was $1.39 \pm 0.36 \times 10^{-3}$ mm^2/s. There was a statistically significant difference among the ADC values of normal myometrium and adenomyosis ($p < 0.0001$), and normal myometriumand fibroids ($p < 0.001$).

In the study done by **O. Kilickesmez et al**[4] the ADC value for normal myometrium (n=50,mean ADC value $1.769+/-0.19 \times 10^{-3}$ mm^2/s) was in accordance to our study.

This was in agreement with a previous study done by **Bader S.J. et al.(2017)**[91] with the mean ADC of normal myometrium being $1.3018+/-0.0564 \times 10^{-3}$ mm^2/s.

Table 13: Comparison of mean+/- standard deviation of ADC values in normal myometrium.

Study	Mean ± sd	Comparision
Present study	1493 +/- 392.48 x10^{-6} mm^2 /s	
Liapi et al.[5]	2050 x10^{-6} mm^2 /s	discordance
Tamai et al.[23]	1620 x10^{-6} mm^2 /s	accordance
Jha RC et al., (2014)[27]	1.39 ± 0.36×10^{-3} mm^2/s	accordance
O. Kilickesmez et al[4]	1.769+/-0.19×10^{-3} mm^2/s	accordance
Bader S.J. et al.(2017)[91]	1.3018+/- 0.0564×10^{-3} mm^2/s	accordance

MYOMETRIAL PATHOLOGIES

Our results demonstrated that the mean ADC values +/-standard deviation x10^{-6} mm^2/s of the myometrial lesions were as follows:

- Cellular fibroid :431.7 +/-174.4 x10^{-6} mm^2 /s
- Usual leiomyoma :681.10 +/- 365.74 x10^{-6} mm^2 /s
- Fibroid with hyaline change :757.43 +/- 275.75x10^{-6} mm^2 /s
- Fibroid with hyaline change &necrosis :759.00 +/ 209.30 x10^{-6} mm^2 /s
- Adenomyoma :823.00 +/- 73.6 x10^{-6} mm^2 /s
- Adenomyosis :865.13 +/- 195.93 x10^{-6} mm^2 /s
- Myxoleiomyosarcoma:875.00 x10^{-6} mm^2 /s
- Fibroid with lymphoid infiltrates: 1004.00 x10^{-6} mm^2 /s
- Lipoleimoma:1489.50 +/- 68.59 x10^{-6} mm^2 /s
- Normal myometrium :1493 +/- 392.48 x10^{-6} mm^2 /s

- USUAL LEIOMYOMA

In the study done by **Jha RC et al., (2014),**[27] the mean and the standard deviation of the ADC values of fibroids was 0.64 ± 0.29×10^{-3} mm^2/s and myometrium 1.39 ± 0.36×10^{-3} mm^2/s. There was a statistically significant difference among the ADC values of normal myometrium and fibroids ($p < 0.0001$). This study was in accordance with our study.

Tamai et al.[23] stated that the mean ADC value for ordinary leiomyomas was 880 x10^{-6} mm^2/s which corroborated with our study.

The findings in our study were also in agreement with a previous study done by **Bader S.J. et al.(2017)**[91] which showed the mean ADC of fibroids to be 0.63×10^{-3} mm^2/s. Statically, there was significant difference between the ADC values of normal myometrium and fibroids ($p < 0.0001$).

According to the findings of **Lin G et al., (2016),**[100] the ADC value (×10^{-3} mm^2/s) of ordinary leiomyomas (1.14 +/- 0.16) was higher than that seen in our study.The difference may be due to differential experimental settings, including the hardware facilities and technical parameters.

Table 14: Comparison of mean+/- standard deviationof ADC values in usual leiomyomas.

Study	Mean±SD	Comparision
Present study	681.10 +/- 365.74 x10^{-6} mm^2 /s	
Jha RC et al., (2014)[27]	0.64 ± 0.29×10^{-3} mm^2/s	accordance
Bader S.J. et al.(2017)[91]	0.63×10^{-3} mm^2/s	accordance
Tamai et al.[23]	880 x10^{-6} mm^2/s	accordance
Lin G et al., (2016)[100]	1.14 +/- 0.16×10^{-3} mm^2/s	discordance

- CELLULAR LEIOMYOMA

Tamai et al.[23] stated that the mean ADC value of the cellular leiomyomas 1190 x10^{-6} mm^2 /s was significantly higher than seen in our study.The difference may be due to differential experimental settings, including the hardware facilities and technical parameters.

In the study done by **O. Kilickesmezet al**[4] there was a statistically significant differences among the ADC values of normal myometrium and leiomyomas (1.47+/-0.36×10^{-3} mm^2/s) ($p < 0.001$), normal myometrium (n=50,mean ADC value 1.769+/-0.19×10^{-3} mm^2/s) Leiomyoma (n= 35, mean ADC value 1.47+/-0.36×10^{-3} mm^2/s. This finding was significantly greater than the ADC values obtained in our study.The difference may be

due to differential cellular milleu in the fibroids which was not distinguished in this study.

According to the findings of **Lin G et al., (2016),**[100] the ADC value (×10^{-3} mm^2/s) of cellular leiomyomas (1.43 +/- 0.58) was higher than that found in our study. The difference may be due to differential experimental settings, including the hardware facilities and technical parameters.

As per a study done by **Bonde Apurva et al (2022)[101]** different cut off for ADC values, for example, less than 1.1 × 10^{-3} mm^2/s or less than 1.08 × 10^{-3} mm^2/s, were investigated and proposed for aiding the differentiation between cellular uterine fibroid and leiomyosarcoma and were found to be somewhat useful.

Table 15: Comparison of mean+/- standard deviationof ADC values in cellular leiomyomas.

Study	Mean±SD	Comparision
Present study	431.7 +/-174.4 x10^{-6} mm^2 /s	-
Tamai et al.[23]	1190 x10^{-6} mm^2 /s	discordance
O. Kilickesmezet al [4]	1.47+/-0.36×10^{-3} mm^2/s	discordance
Lin G et al., (2016)[100]	1.43 +/- 0.58x10^{-3} mm^2/s	discordance
Bonde Apurva et al (2022)[101]	1.08 × 10^{-3} mm^2/s	accordance

- FIBROID WITH HYALINE CHANGE

Our study was corroborated with the findings of **Sato K et al., (2014)**[86] which stated that the mean ADC value for leiomyoma nodules that presented with intermediate-intensity areas was 1.472 ± 0.285 ×10^{-3} mm^2/s (n = 41) (P < .001), and of high-intensity areas was1.100 ± 0.343×10^{-3} mm^2/s (n = 9) (P = 0.03).

The study done by **Erdem et al., (2007)**[6] was in accordance with our study. It showed that leiomyomas had significantly lower ADC values than

adjacent or normal myometrial tissues (1201 vs. 1684 and 1661 $x10^{-6}$ mm^2 /s).

According to **Liapi et al.**[5], leiomyomas had a mean ADC value of 1740 $x10^{-6}$ mm^2 /s before embolization, and 1220 $x10^{-6}$ mm^2 /s after embolization. These researchers proposed to use ADC changes in therapeutic assessment in uterine fibroids. The difference may be due to differential experimental settings, including the hardware facilities and technical parameters.

According to the study of **Shimada et al.**[103], leiomyomas with different histological characteristics had similar signal features on T2 -weighted images, but their ADC values were different. Mean ADC values of hyalinized leiomyomas was< 2000 $x10^{-6}$ mm^2 /s. This value is higher than the one found by us. Shimada et al also stated that mean ADC value of hyalinized leiomyomas was lower lower than the ordinary leiomyoma subtype. This was in discordance to our study. The difference may be due to differential experimental settings, including the hardware facilities and technical parameters.

Tamai et al.[23] stated that the mean ADC value of degenerated leiomyoma (1700 $x10^{-6}$ mm^2/s) which was higher than normal myometrium(1620 $x10^{-6}$ mm^2 /s) which was in discordance from our study.The difference may be due to differential experimental settings, including the hardware facilities and technical parameters.

According to the findings of **Lin G et al., (2016)**[100] the ADC value ($\times 10^{-3}$ mm^2/s) of degenerated leiomyomas (1.17 +/- 0.17) was in accordance to our study.

Table 16: Comparison of mean+/- standard deviation of ADC values in fibroid with hyaline change.

Study	Mean±SD	Comparision
Present study	757.43 +/- 275.75 $x10^{-6}$ mm^2 /s	
Sato K et al., (2014)[86]	1.472 ± 0.285 $\times10^{-3}$ mm^2/s	accordance
Erdem G et al., (2009)[4]	1201 $x10^{-6}$ mm^2 /s	accordance
Lin G et al., (2016)[100]	1.17 +/- 0.17 $\times10^{-3}$ mm^2/s	accordance
Liapi E et al., (2005)[5]	1740 $x10^{-6}$ mm^2	discordance
Shimada K et al., (2004)[103]	2000 $x10^{-6}$ mm^2 /s	discordance
Tamai K et al., (2008)[23]	1700 $x10^{-6}$ mm^2/s	discordance

- ADENOMYOSIS

The study done by **Jha RC et al., (2014)**[27] was in accordance with our study. It showed the mean and the standard deviation of the ADC values of adenomyosis was 0.86 ± 0.30 and of myometrium was 1.39 ± 0.36×10^{-3} mm^2/s. There was a statistically significant difference among the ADC values of normal myometrium and adenomyosis ($p < 0.0001$), and fibroids and adenomyosis ($p < 0.001$).

In the study done by **O. Kilickesmezet al[4],**in 12 patients of adenomyosisthe mean and the standard deviation of the ADC values was 1.24+/-0.20×10^{-3} mm^2/s. These findings corroborated with our study.

Our study was also in agreement with a previous study done by **Bader S.J. et al.(2017)**[91] which showed that the mean ADC of adenomyosis was 0.75×10^{-3} mm^2/s. Statically, there was significant difference between the ADC values of normal myometrium and adenomyosis ($p < 0.0001$) and fibroids and adenomyosis ($p < 0.001$).

Table 17: Comparison of mean+/- standard deviation of ADC values in adenomyosis.

Study	Mean±SD	Comparision
Present study	865.13 +/- 195.93 x10^{-6} mm^2 /s	-
Jha RC et al., (2014)[27]	0.86 ± 0.30×10^{-3} mm^2/s	accordance
Kilickesmez O et al., (2009)[4]	1.24+/-0.20×10^{-3} mm^2/s	accordance
Bader S.J. et al., (2017)[91]	0.75×10^{-3} mm^2/s	accordance

- MYXOID LEIOMYOSARCOMA

According to the findings of **Sato K et al., (2014)**[86] the mean ADC value for the 10 leiomyosarcoma lesions was 0.791 ± 0.145 ×10^{-3} mm^2/s. The highest ADC value for a leiomyosarcoma was 1.095×$10^{-3}$$mm^2$/s, with an intermediate DWI intensity. These findings were similar to the ADC value in our study for the myxoidleiomyosarcoma.

According to the findings of **Lin G et al., (2016)**[100] the ADC value of LMS (mean +/- standard deviation, 1.05+/-0.41×10^{-3} mm^2/s)was significantly lower than that of benign leiomyomas (median 1.19×10^{-3} mm^2/s, range 0.70–2.04×10^{-3} mm^2/s, P < 0.05, Mann–Whitney U test). A combination of DWI and ADC cut off value of 1.08 ×10^{-3} mm^2/s improved the diagnostic accuracy, sensitivity, and specificity of DWIto 0.88, 0.88, and 0.88, respectively.

Table 18: Comparison of mean+/- standard deviation of ADC values in myxoid leiomyosarcoma.

Study	Mean±SD	Comparision
Present study	875.00 x10^{-6} mm^2 /s	-
Sato K et al., (2014)[86]	0.791 ± 0.145 ×10^{-3} mm^2/s	accordance
Lin G et al., (2016)[100]	0.89×10^{-3} mm^2/s	accordance

SUMMARY AND CONCLUSION

1. Our study included 52 patients with the maximum number of patients (22 out of 52,42.3%) between 41-50 years of age.
2. Most common complain of the patients was abnormal uterine bleeding seen in 33 patients (63.5%).
3. On MRI 92 diseases were identified, of them 38 lesions (41.3%) were fibroid which contributed the majority of the lesions.
4. According to DWI on MRI, diffusion restriction was seen in only 8(8.7%) lesions which comprised of all the 3 cellular fibroids, 3 fibroids with hyaline change, 1 fibroid with lymphoid infilterate and 1 adenomyoma.
5. 84 (91.3%) subjects had no diffusion restriction.
6. 5 (71.4%) out of 7 cases in whom contrast was administered on MRI, showed heterogenous enhancement.
7. The mean ADC value with standard deviation of the normal myometrium in our patients was 1493 +/- 392.48 $x10^{-6}$ mm^2/s and of all the various pathologies was 778.83 ± 288.41x 10^{-6} mm^2/s.
8. Using ROC analysis a max. cut off ADC value of 1007 $x10^{-6}$ mm^2 /s was established to differentiate between pathological myometrium and normal myometrium which had an 88.04%sensitivity and 98.91%specificity and yielded an AUC of 95.4%.
9. The ADC values of lipoleiomyoma was the highest and came very close to the value of the normal myometrium which was slightly higher. The least ADC value was observed in cellular fibroids with usual leiomyomas projected mildly higher values.
10. Adenomyosis and adenomyomas had higher ADC values than usual and cellular variety of leiomyomas.

11. The ADC value of the single malignant lesion (myxoid leiomyosarcoma) in our experience came close to the mean value seen in adenomyosis. It's ADC value was higher than the values observed in fibroids and adenomyosis except for lipoleiomyoma and the fibroid with lymphoid infilterate.

CONCLUSION

- DWI is a sensitive tool in detection of myometrial lesions. However, DWI as a lone parameter has low significance in terms of accurately determining the nature of the myometrial lesion. Cellular fibroids are close differentials of low-grade stromal sarcomas on conventional imaging. Hence, in these cases, DWI and ADC in combination with conventional sequences is a novel technique useful to differentiate the malignant sarcomas from benign fibroids.
- DWI and ADC, appears to be a viable and trustworthy tool for identifying the features of myometrial lesions and delineating benign pathologies, with high specificity and sensitivity.
- A significant difference in the ADC values of adenomyosis, most variety of fibroids, and myometrium was obtained in our study. These differences may be exploited to differentiate adenomyosis from fibroids when the conventional imaging features are non-diagnostic.
- DWI/ADC requires no contrast administration, hence can be performed in patients with renal dysfunction or allergy to gadolinium-based contrast.

LIMITATIONS

The major limitation of our study was a that it was a single centre study with a relatively small sample size. The other limitation of our study was the lack of significant number of malignant lesions in our analysis which deterred us from drawing conclusions with respect to differentiating benign and malignant myometrial pathologies.

BIBLIOGRAPHY

1. Drake RL, Vogl W, Mitchell AW, Gray H. Female urogenital, upper genital tract, Gray's anatomy for students. Available from: http://www.elsevier-etextbooks.com/product/grays-anatomy-for-students.
2. Britannica, The Editors of Encyclopaedia. "uterus". Encyclopedia Britannica, 2023. Available from: https://www.britannica.com/science/uterus.
3. David S. Textbook of radiology and imaging. David Sutton (ed.). 2003;11:1075-7.
4. Kilickesmez O, Bayramoglu S, Inci E, Cimilli T, Kayhan A. Quantitative diffusion-weighted magnetic resonance imaging of normal and diseased uterine zones. Acta Radiol 2009;50:340-7.
5. Liapi E, Kamel IR, Bluemke DA, Jacobs MA, Kim HS. Assessment of response of uterine fibroids and myometrium to embolization using diffusion-weighted echoplanar MR imaging. J Comput Assist Tomogr. 2005;29:83-6.
6. Erdem G, Celik O, Karakas HM, Hascalik S, Firat AK. Microstructural changes in uterine leiomyomas and myometrium: a diffusion-weighted magnetic resonance imaging study. Gynl Obs Invest. 2009;67:217-22.
7. Siegler AM, Camilien L. Adenomyosis. J of repro med. 1994;39: 841-53.
8. Aziz R. Adenomyosis: current perspectives. Obs Gyn Clin N Am. 1989;16:221-35.
9. Tamai K, Togashi K, Ito T, Morisawa N, Fujiwara T, Koyama T. MR imaging findings of adenomyosis: correlation with histopathologic features and diagnostic pitfalls. Radiographics. 2005;25:21-40.
10. Reinhold C, McCarthy S, Bret PM, Mehio A, Atri M, Zakarian R, et al. Diffuse adenomyosis: comparison of endovaginal US and MR imaging with histopathologic correlation. Radiology. 1996;199:151-8.

11. Sanders RC, Winter TC, editors. Clinical sonography: a practical guide. Lippincott Williams & Wilkins; 2007;31:302-5.
12. Amant F, Coosemans A, Debiec-Rychter M, Timmerman D, Vergote I. Clinical management of uterine sarcomas. Lancet Oncol. 2009;10:1188-98.
13. Brooks SE, Zhan M, Cote T, Baquet CR. Surveillance, epidemiology, and end results analysis of 2677 cases of uterine sarcoma 1989–1999. Gynecol Oncol. 2004;93:204-8.
14. Laughlin SK, Schroeder JC, Baird DD. New directions in the epidemiology of uterine fibroids. Semin Reprod Med. 2010;28:204-17.
15. Guntupalli SR, Ramirez PT, Anderson ML, Milam MR, Bodurka DC, Malpica A. Uterine smooth muscle tumor of uncertain malignant potential: a retrospective analysis. Gynecol Oncol 2009;113:324-6.
16. Leibsohn S, d'Ablaing G, Mishell DR Jr, Schlaerth JB. Leiomyosarcoma in a series of hysterectomies performed for presumed uterine leiomyomas. Am J ObstetGynecol.1990;162:968-74.
17. Metwally M, Cheong YC, Horne AW. Surgical treatment of fibroids for subfertility. Cochrane Database Syst Rev. 2012;11:CD003857.
18. Gupta JK, Sinha AS, Lumsden MA, Hickey M. Uterine artery embolization for symptomatic uterine fibroids. Cochrane Database Syst Rev. 2006:CD005073.
19. Kim HS, Baik JH, Pham LD, Jacobs MA. MR-guided high-intensity focused ultrasound treatment for symptomatic uterine leiomyomata: long-term outcomes. AcadRadiol. 2011;18:970-6.
20. Wu TI, Yen TC, Lai CH. Clinical presentation and diagnosis of uterine sarcoma, including imaging. Best Pract Res Clin ObstetGynecol. 2011;25:681-9.
21. Ueda H, Togashi K, Konishi I, Kataoka ML, Koyama T, Fujiwara T, et al. Unusual appearances of uterine leiomyomas: MR imaging findings

and their histopathologic backgrounds. Radiographics. 1999;19:S131-45.

22. Cornfeld D, Israel G, Martel M, Weinreb J, Schwartz P, McCarthy S. MRI appearance of mesenchymal tumors of the uterus. Eur J Radiol. 2010;74:241-9.
23. Tamai K, Koyama T, Saga T, Morisawa N, Fujimoto K, Mikami Y, et al. The utility of diffusion-weighted MR imaging for differentiating uterine sarcomas from benign leiomyomas. Eur Radiol. 2008;18:723-30.
24. Namimoto T, Yamashita Y, Awai K, Nakaura T, Yanaga Y, Hirai T, et al. Combined use of T2-weighted and diffusion-weighted 3-T MR imaging for differentiating uterine sarcomas from benign leiomyomas. Eur Radiol. 2009;19:2756-64.
25. Coutinho AC Jr, Krishnaraj A, Pires CE, Bittencourt LK, Guimarães AR. Pelvic applications of diffusion magnetic resonance images. Magn Reson Imaging Clin N Am. 2011;19:133-57.
26. Busard MP, Mijatovic V, van Kuijk C, Pieters-van den Bos IC, Hompes PG, van Waesberghe JH. Magnetic resonance imaging in the evaluation of (deep infiltrating) endometriosis: the value of diffusion-weighted imaging. J MagnReson Imaging. 2010;32:1003-9.
27. Tasaki A, Asatani MO, Umezu H, Kashima K, Enomoto T, Yoshimura N, et al. Differential diagnosis of uterine smooth muscle tumors using diffusion-weighted imaging: correlations with the apparent diffusion coefficient and cell density. Abdom Imaging. 2015;40:1742-52.
28. Wasnik AP, Mazza MB, Liu PS. Normal and variant pelvic anatomy on MRI. MagnReson Imaging Clin N Am. 2011;19:547-66.
27. Jha RC, Zanello PA, Ascher SM, Rajan S. Diffusion-weighted imaging (DWI) of adenomyosis and fibroids of the uterus. Abdom Imaging. 2014;39:562-9.
28. Huang YL, Ueng SH, Chen K, Huang YT, Lu HY, Ng KK, et al. Utility of diffusion-weighted and contrast-enhanced magnetic resonance

imaging in diagnosing and differentiating between high- and low-grade uterine endometrial stromal sarcoma. Cancer Imaging. 2019;19:63.

29. Kido A, Kataoka M, Koyama T, Yamamoto A, Saga T, Togashi K. Changes in apparent diffusion coefficients in the normal uterus during different phases of the menstrual cycle. Br J Radiol. 2010;83:524-8.
30. Sener RN. Diffusion MRI: apparent diffusion coefficient (ADC) values in the normal brain and a classification of brain disorders based on ADC values. Comput Med Imaging Graph. 2001;25: 299-326.
31. Magnetic Resonance Tomography. Springer. (2008) ISBN:3540293558.
32. Mascalchi M, Filippi M, Floris R, Fonda C, Gasparotti R, Villari N. Diffusion-weighted MR of the brain: methodology and clinical application. Radiol Med. 2005;109:155-97.
33. Rana S, Albayram S, Lin DD, Yousem DM. Diffusion-weighted imaging and apparent diffusion coefficient maps in a case of intracerebral abscess with ventricular extension. AJNR Am J Neuroradiol. 2002;23:109-12.
34. El Kady RM, Choudhary AK, Tappouni R. Accuracy of apparent diffusion coefficient value measurement on PACS workstation: A comparative analysis. AJR Am J Roentgenol. 2011;196:W280-4.
35. Moritani T, Ekholm S, Westesson PL. Diffusion-Weighted MR Imaging of the Brain. Springer. (2009) ISBN:3540787852.
36. Greenberg MS. Handbook of Neurosurgery. Thieme. (2010) ISBN:1604063262.
37. UK. PP. Diffusion MRI: Theory, Methods, and Applications, Theory, Methods, and Applications. Oxford University Press, USA. (2010) ISBN:0199708703.
38. Harris AD, Pereira RS, Mitchell JR, Hill MD, Sevick RJ, Frayne R. A comparison of images generated from diffusion-weighted and

diffusion-tensor imaging data in hyper-acute stroke. Journal of magnetic resonance imaging: JMRI. 2004;20:193-200.

39. De Foer B, Vercruysse JP, Pilet B, Michiels J, Vertriest R, Pouillon M, et al. Single-shot, turbo spin-echo, diffusion-weighted imaging versus spin-echo-planar, diffusion-weighted imaging in the detection of acquired middle ear cholesteatoma. AJNR Am J Neuroradiol. 2006;27:1480-2.
40. Haaga JR, Boll D. CT and MRI of the whole body. Mosby. (2009) ISBN:0323053750.
41. Helenius J, Soinne L, Perkiö J, Salonen O, Kangasmäki A, Kaste M, et al. Diffusion-weighted MR imaging in normal human brains in various age groups. AJNR Am J Neuroradiol. 2002;23:194-9.
42. Annet L, Duprez T, Grandin C, Dooms G, Collard A, Cosnard G. Apparent diffusion coefficient measurements within intracranial epidermoid cysts in six patients. Neuroradiology. 2002;44:326-8.
43. Hilario A, Ramos A, Perez-Nuñez A, Salvador E, Millan JM, Lagares A, et al. The added value of apparent diffusion coefficient to cerebral blood volume in the preoperative grading of diffuse gliomas. AJNR Am J Neuroradiol. 2012;33:701-7.
44. Fujii S, Matsusue E, Kigawa J, Sato S, Kanasaki Y, Nakanishi J, et al. Diagnostic accuracy of the apparent diffusion coefficient in differentiating benign from malignant uterine endometrial cavity lesions: initial results. Eur Radiol. 2008;18:384-9.
45. Tropeano G, Amoroso S, Scambia G. Non-surgical management of uterine fibroids. Hum Reprod Update. 2008;14:259-74.
46. Goto A, Takeuchi S, Sugimura K, Maruo T. Usefulness of Gd-DTPA contrast-enhanced dynamic MRI and serum determination of LDH and its isozymes in the differential diagnosis of leiomyosarcoma from degenerated leiomyoma of the uterus. Int J Gynecol Cancer. 2002;12:354-61.

47. Catherino WH, Leppert PC, Stenmark MH, Payson M, Potlog-Nahari C, Nieman LK, et al. Reduced dermatopontin expression is a molecular link between uterine leiomyomas and keloids. Genes Chromosomes Cancer. 2004;40:204-17.
48. Leppert PC, Baginski T, Prupas C, Catherino WH, Pletcher S, Segars JH. Comparative ultrastructure of collagen fibrils in uterine leiomyomas and normal myometrium. FertilSteril. 2004;82:1182-7.
49. Namimoto T, Awai K, Nakaura T, Yanaga Y, Hirai T, Yamashita Y. Role of diffusion-weighted imaging in the diagnosis of gynecological diseases. EurRadiol. 2009;19:745-60.
50. Jacobs MA, Herskovits EH, Kim HS. Uterine fibroids: diffusion-weighted MR imaging for monitoring therapy with focused ultrasound surgery-preliminary study. Radiology. 2005;236:196-203.
51. Benagiano G, Habiba M, Brosens I. The pathophysiology of uterine adenomyosis: an update. FertilSteril. 2012;98:572-9.
52. McElin T, Bird C. Adenomyosis of the uterus. Obstet Gynecol Annu. 1974;3:425-41.
53. Vercellini P, Parazzini F, Oldani S, Panazza S, Bramante T, Crosignani PG. Adenomyosis at hysterectomy: a study on frequency distribution and patient characteristics. Hum Reprod. 1995;10:1160-2.
54. Templeman C, Marshall SF, Ursin G. Adenomyosis and endometriosis in the California teachers study. FertilSteril. 2008;90:415-24.
55. Riggs JC, Lim EK, Liang D, Bullwinkel R. Cesarean section as a risk factor for the development of adenomyosis uteri. J Reprod Med. 2014;59:20-4.
56. Ferenczy A. Pathophysiology of adenomyosis. Hum Reprod Update. 1998;4:312-22.

57. Matsumoto Y, Iwasaka T, Yamasaki F, Sugimori H. Apoptosis and Ki-67 expression in adenomyotic lesions and in the corresponding eutopic endometrium. Obstet Gynecol. 1999;94:71-7.
58. Mutter G. Pathology of the female reproductive tract. 3. London: Churchill Livingstone Elsevier; 2014.
59. Lee D, Kim H, Yoon B, Choi D. Clinical characteristics of adolescent Endometrioma. J Pediatr Adolesc Gynecol. 2013;26: 117-9.
60. Itam S, Ayensu-Coker L, Sanchez J, Zurawin R, Dietrich J. Adenomyosis in the adolescent population: a case report and review of the literature. J Pediatr Adolesc Gynecol. 2009;22:e146-7.
61. Brosens I, Gordts S, Habiba M, Benagiano G. Myometrial cystic adenomyosis: a young people disorder. J Pediatr Adolesc Gynecol. 2015;28:420-6.
62. Seidman J, Kjerulff K. Pathologic findings from the Maryland Women's health study: practice patterns in the diagnosis of adenomyosis. Int J Gynecol Pathol. 1996;15:217-21.
63. Benagiano G, Brosens I, Habiba M. Adenomyosis: a life-cycle approach. Reprod Bio Med Online. 2015;30:220-32.
64. Levy G, Dehaene A, Laurent N, Lernout M, Collinet P, Lucot J, et al. An update on adenomyosis. DiagnInterv Imaging. 2013;94:3-25.
65. Madelenat P, Sureau C. Groupe d'études de l'endométriose: résultats de l'enquête d'épidémiologie descriptive en milieu hospitalier 712 cas-année 1983. Actualités gynécologiques (Paris. 1971). 1985;16:115-24.
66. Novellas S, Chassang M, Delotte J, Toullalan O, Chevallier A, Bouaziz J, et al. MRI characteristics of the uterine junctional zone: from normal to the diagnosis of adenomyosis. AJR Am J Roentgenol. 2011;196:1206-13.
67. Bazot M, Cortez A, Darai E, Rouger J, Chopier J, Antoine J, et al. Ultrasonography compared with magnetic resonance imaging for the

diagnosis of adenomyosis: correlation with histopathology. Hum Reprod. 2001;16:2427-33.

68. Ascher S, Arnold L. Adenomyosis: prospective comparison of MR imaging and transvaginal sonography. Radiol. 1994;190:803-6.
69. Dueholm M, Lundorf E, Hansen ES, Sorensen JS, Ledertoug S, Olesen F. Magnetic resonance imaging and transvaginal ultrasonography for the diagnosis of adenomyosis. Fertil Steril. 2001;76:588-94.
70. Agostinho LI, Cruz R, Guerra A, Barata MJ, Setubal A. Adenomyosis and MRI: what you need to know and be aware of. European Congress of Radiology-ECR 2016.
71. Larsen S, Lundorf E, Forman A, Dueholm M. Adenomyosis and junctional zone changes in patients with endometriosis. Eur J Obstet Gynecol Reprod Biol. 2011;157:206-11.
72. Reinhold C, Tafazoli F, Mehio A. Uterine adenomyosis: endovaginal US and MR imaging features with histopathologic correlation. Radiographics. 1999;19:S147-60.
73. Kang S, Turner D, Foster G, Rapoport M, Spencer S, Wang J. Adenomyosis: specificity of 5 mm as the maximum normal uterine junctional zone thickness in MR images. Am J Roentgenol. 1996;166:1145-50.
74. Gordts S, Brosens JJ, Fusi L, Benagiano G, Brosens I. Uterine adenomyosis: a need for uniform terminology and consensus classification. Reprod BioMed Online. 2008;17:244-8.
75. Togashi K, Kawakami S, Kimura I, Asato R, Okumura R, Fukuoka M, et al. Uterine contractions: possible diagnostic pitfall at MR imaging. Journal of Magnetic Resonance Imaging. 1993;3:889-93.
76. Johnson W, Taylor M. The value of hyoscine butylbromide in pelvic MRI. Clin Radiol. 2007;62:1087-93.

77. Takeuchi M, Matsuzaki K. Adenomyosis: usual and unusual imaging manifestations, pitfalls and problem-solving MR imaging techniques. Radiographics. 2011;31:99-115.
78. Gilks CB, Clement PB, Hart WR, Young RH. Uterine adenomyomas excluding atypical polypoid adenomyomas and adenomyomas of endocervical type: a clinicopathologic study of 30 cases of an underemphasised lesion that may cause diagnostic problems with brief consideration of adenomyomas of other female genital tract sites. Int J GynecolPathol. 2000;19:195-205.
79. Hamm B, Forstener R. MRI and CT of the female pelvis. 1. Berlim: Springer; 2007.
80. Wolfman D, Ascher S. Magnetic resonance imaging of benign uterine pathology. Top Magn Reson Imaging. 2006;17:399-407.
81. Acién P, Acién M, Fernández F, Mayol MJ, Aranda I. The cavitated accessory uterine mass: a Müllerian anomaly in women with an otherwise normal uterus. Obstetrics & Gynecology. 2010;116:1101-9.
82. Acién P, Bataller A, Fernández F, Acién MI, Rodríguez JM, Mayol MJ. New cases of accessory and cavitated uterine masses (ACUM): a significant cause of severe dysmenorrhea and recurrent pelvic pain in young women. Human Reproduction. 2012;27:683-94.
83. Kunz G, Beil D, Huppert P, Noe M, Kissler S, Leyendecker G. Adenomyosis in endometriosis--prevalence and impact on fertility. Evidence from magnetic resonance imaging. Hum Reprod. 2005;20:2309-16.
84. Bazot M, Fiori O, Darai E. Adenomyosis in endometriosis—prevalence and impact on fertility. Evidence from magnetic resonance imaging. Hum Reprod. 2006;20:2309-16.
85. Indraccolo U, Barbieri F. Relationship between adenomyosis and uterine polyps. Eur J Obstet Gynecol Reprod Biol. 2011;157:185-9.
86. Sato K, Yuasa N, Fujita M, Fukushima Y. Clinical application of diffusion-weighted imaging for preoperative differentiation between

uterine leiomyoma and leiomyosarcoma. American journal of obstetrics and gynecology. 2014;210:368-e1.

87. Bakir B, Yilmaz F, Turkay R, Özel S, Bilgiç B, Velioglu A, et al. Role of diffusion-weighted MR imaging in the differentiation of benign retroperitoneal fibrosis from malignant neoplasm: preliminary study. Radiology. 2014;272:438-45.
88. Yang D, Zhu YX, Wang X, Ye XJ, Yan ZH, Liu K, et al. Diffusion-weighted imaging characteristics of uterine leiomyomas with different pathological subtypes at 3.0 T. Zhonghua yi xue za zhi. 2016;96:1155-9.
89. Tadros MY, Keriakos NN. Diffusion MRI versus ultrasound in superficial and deep endometriosis. The Egyptian Journal of Radiology and Nuclear Medicine 2016;47:1765-71.
90. Lin G, Yang LY, Huang YT, Ng KK, Ng SH, Ueng SH, et al. Comparison of the diagnostic accuracy of contrast-enhanced MRI and diffusion-weighted MRI in the differentiation between uterine leiomyosarcoma/smooth muscle tumor with uncertain malignant potential and benign leiomyoma. Journal of Magnetic Resonance Imaging. 2016;43:333-42.
91. Bader SJ, Kassim TA. Role of Diffusion Weighted Imaging (dwi)of Mri Study in Differentiation Between Adenomyosis and Fibroids of the Uterus in Al-Hilla Teaching Hospital. Medical Journal of Babylon. 2017;14:606-15.
92. Lakhman Y, Veeraraghavan H, Chaim J, Feier D, Goldman DA, Moskowitz CS, et al. Differentiation of uterine leiomyosarcoma from atypical leiomyoma: diagnostic accuracy of qualitative MR imaging features and feasibility of texture analysis. European radiology. 2017;27:2903-15.
93. Bakir B, Sanli S, Bakir VL, Ayas S, Yildiz SO, Iyibozkurt AC, et al. Role of diffusion weighted MRI in the differential diagnosis of

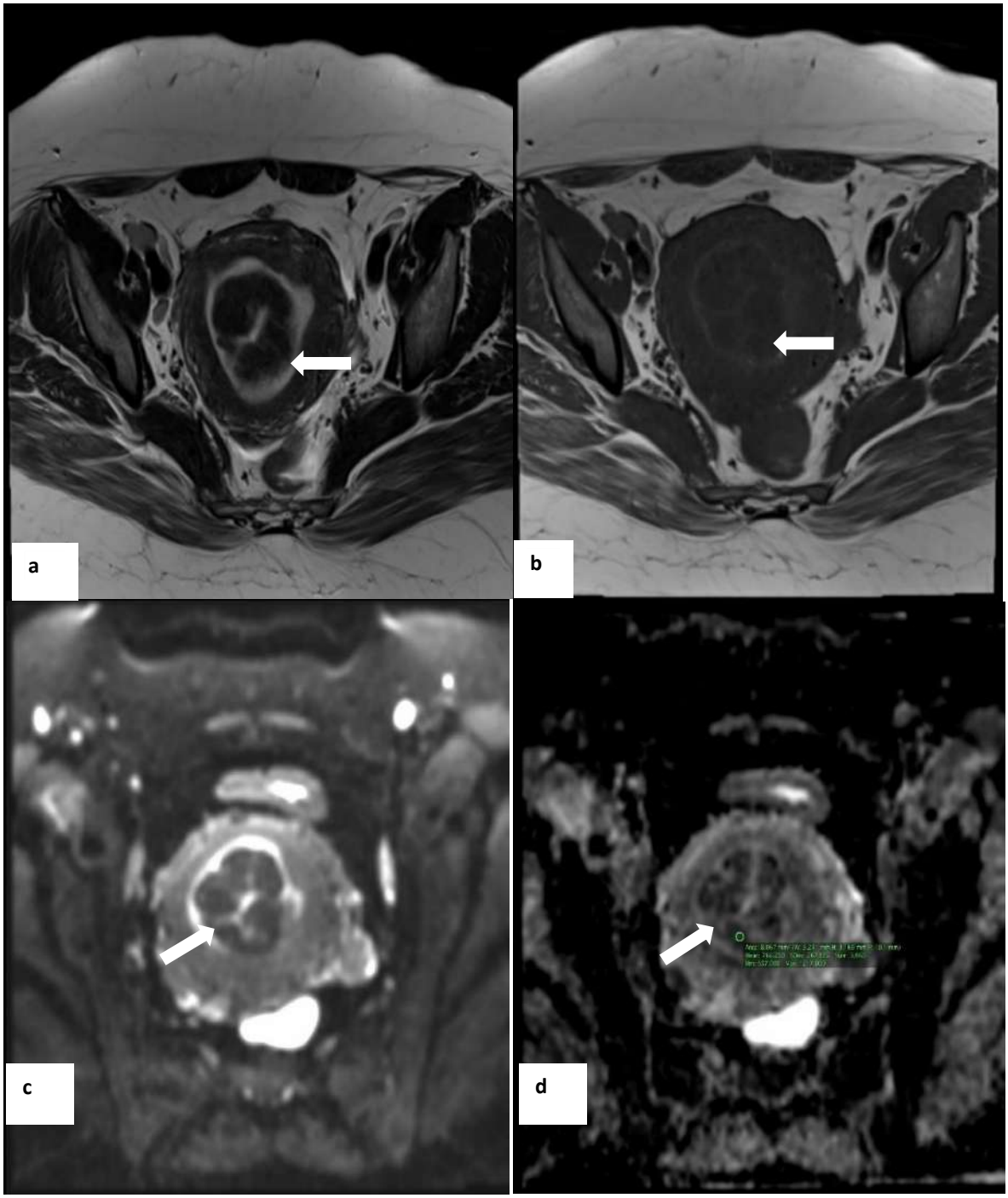
endometrial cancer, polyp, hyperplasia, and physiological thickening. Clinical Imaging. 2017;41:86-94.

94. Onal Y, Samanci C. The role of diffusion-weighted imaging in patients with gastric wall thickening. Current Medical Imaging. 2019;15:965-71.
95. Abdel Wahab C, Jannot AS, Bonaffini PA, Bourillon C, Cornou C, et al. Diagnostic algorithm to differentiate benign atypical leiomyomas from malignant uterine sarcomas with diffusion-weighted MRI. Radiology. 2020;297:361-71.
96. Reyes-Pérez JA, Villaseñor-Navarro Y, Jiménez de Los Santos ME, Pacheco-Bravo I, Calle-Loja M, Sollozo-Dupont I. The apparent diffusion coefficient (ADC) on 3-T MRI differentiates myometrial invasion depth and histological grade in patients with endometrial cancer. Acta Radiol. 2020;61:1277-86.
97. Malek M, Tabibian E, Rahimi Dehgolan M, Rahmani M, Akhavan S, Sheikh Hasani S, et al. A diagnostic algorithm using multi-parametric MRI to differentiate benign from malignant myometrial tumors: Machine-learning method. Scientific Reports. 2020;10:7404.
98. Elsayed SE, Gouhar GK, Hamed EM, Amin MI. Diffusion-weighted images and its application in the clinical diagnostic testing of endometrial focal lesions. The Egyptian Journal of Hospital Medicine. 2022;86:605-12.
99. Tse KY, Crawford R, Ngan HY. Staging of uterine sarcomas. Best Pract Res Clin ObstetGynaecol. 2011;25:733-49.
100. Lin G, Ng KK, Chang CJ, Wang JJ, Ho KC, Yen TC, et al. Myometrial invasion in endometrial cancer: diagnostic accuracy of diffusion-weighted 3.0-T MR imaging—initial experience. Radiology. 2009;250:784-92.
101. Bonde A, Andreazza Dal Lago E, Foster B, Javadi S, Palmquist S, Bhosale P. Utility of the Diffusion Weighted Sequence in Gynecological Imaging. Cancers. 2022;14:4468.

102. Himoto Y, Kido A, Sakata A, Moribata Y, Kurata Y, Suzuki A, et al. Differentiation of uterine low-grade endometrial stromal sarcoma from rare leiomyoma variants by magnetic resonance imaging. Scientific Reports. 2021;11:19124.
103. Shimada K, Ohashi I, Kasahara I, Watanabe H, Ohta S, Miyasaka N, et al. Differentiation between completely hyalinized uterine leiomyomas and ordinary leiomyomas: Three-phase dynamic magnetic resonance imaging (MRI) vs. diffusion-weighted MRI with very small b-factors. Journal of Magnetic Resonance Imaging: An Official Journal of the International Society for Magnetic Resonance in Medicine. 2004;20:97-104.
104. Park Y, Kim MD, Jung DC, Lee SJ, Kim G, Park SI, et al. Can measurement of apparent diffusion coefficient before treatment predict the response to uterine artery embolization for adenomyosis?. European Radiology. 2015;25:1303-9.

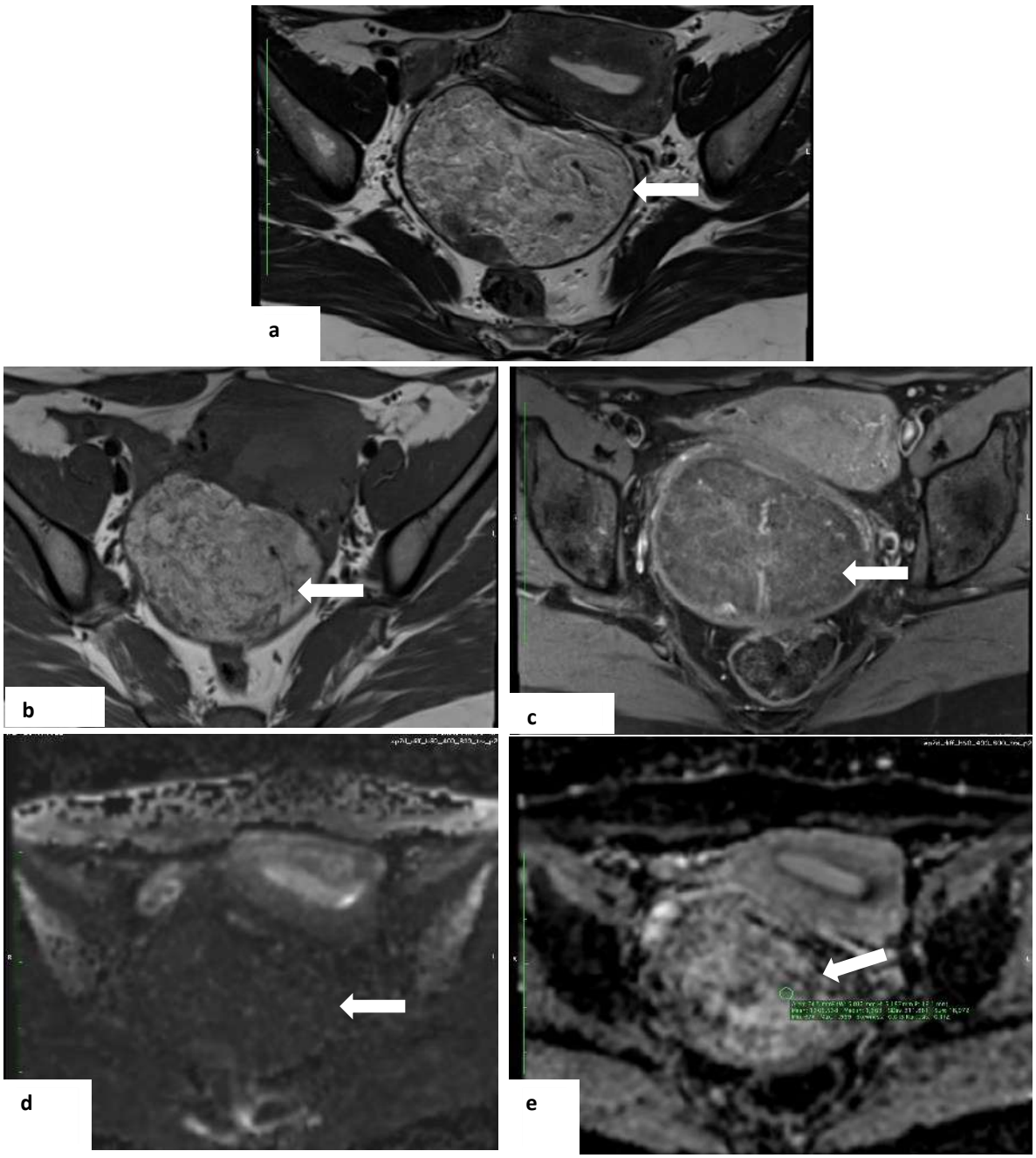
USUAL LEIOMYOMA

Picture 6: A 40year old female presented with abdominal distension since the past few months (patient no. 36 as in the masterchart). On MRI there was a large well defined submucosal lesion (white arrow in images) appearing (a) hypointense on T2WI obl (b) isointense on T1 WI obl and showing(c) no diffusion restriction on DWI tra and (d)ADC tra images.



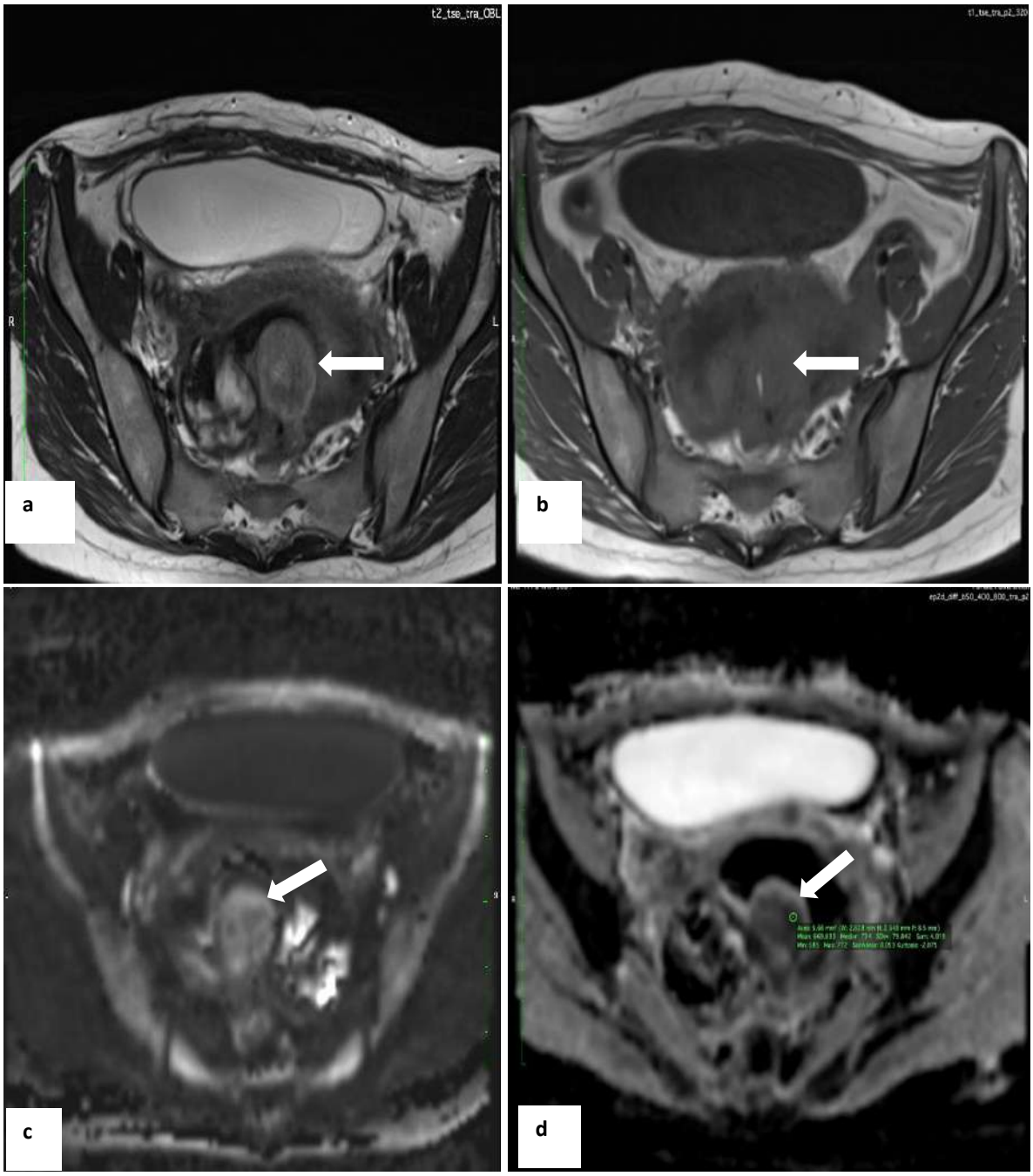
LIPOLEIOMYOMA

Picture 7: A 44 year old female presented with pain and heaviness in abdomen along with abdominal distension and abnormal uterine bleeding since the past few months (patient no. 2 as in the masterchart). On MRI there was a large well defined subserosal lesion (white arrow in images) appearing (a) heterogenously hyperintense on T2WI obl (b)hyperintense on T1 WI obl (c)showing supression of macroscopic fat on T1 fat sat WI obl (d)and showing no diffusion restriction on DWI tra and (e)ADC tra images



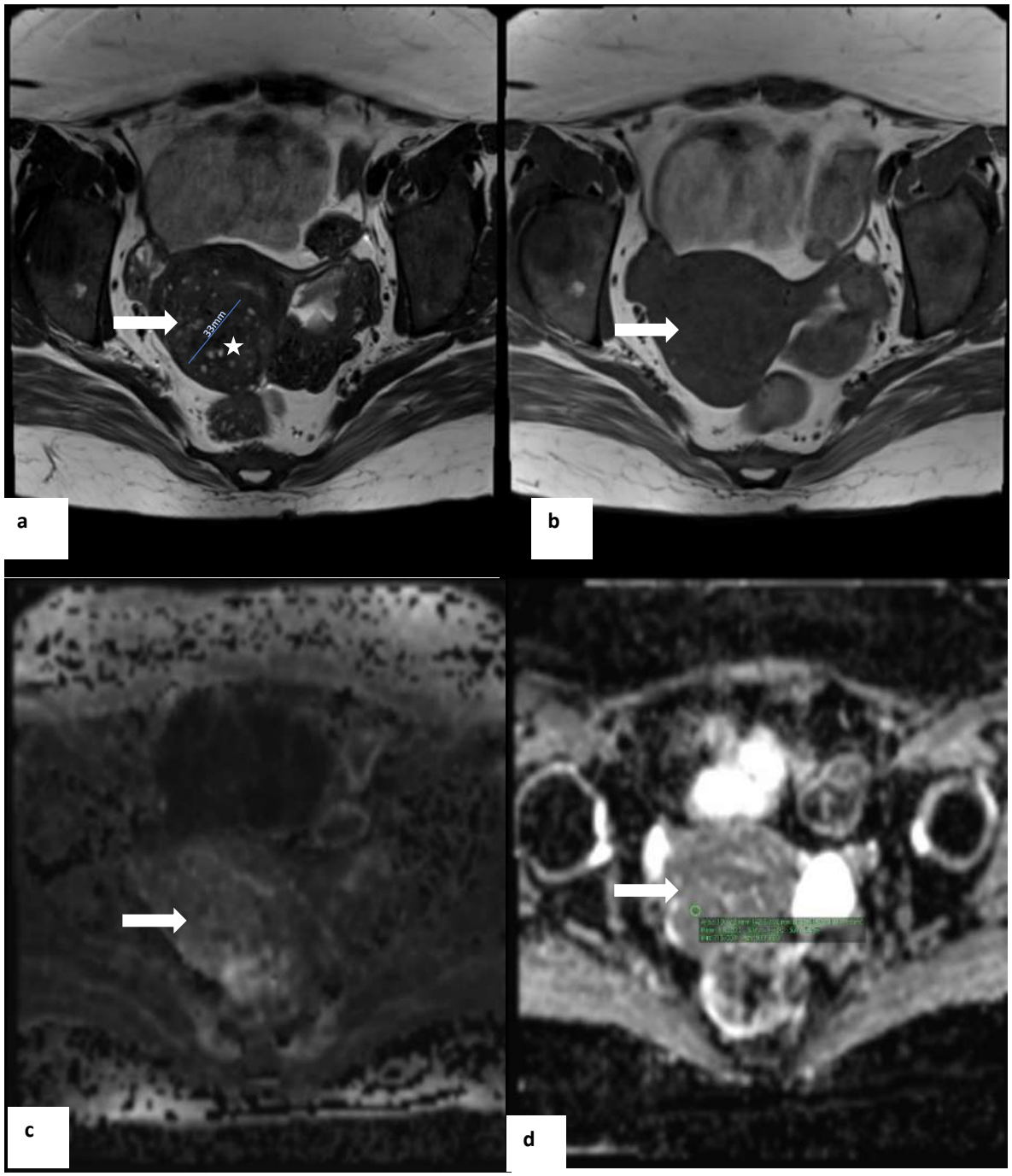
CELLULAR FIBROID

Picture 8: A 23year old female presented with pain abdomen and abnormal uterine bleeding since the past few weeks (patient no. 44 as in the masterchart). On MRI there was a large well defined submucosal lesion (white arrow in images) appearing (a) heterogeneously hyperintense on T2WI obl (b) isointense on T1WI obl (d)and showing diffusion restriction on DWI tra and (e)ADC tra images



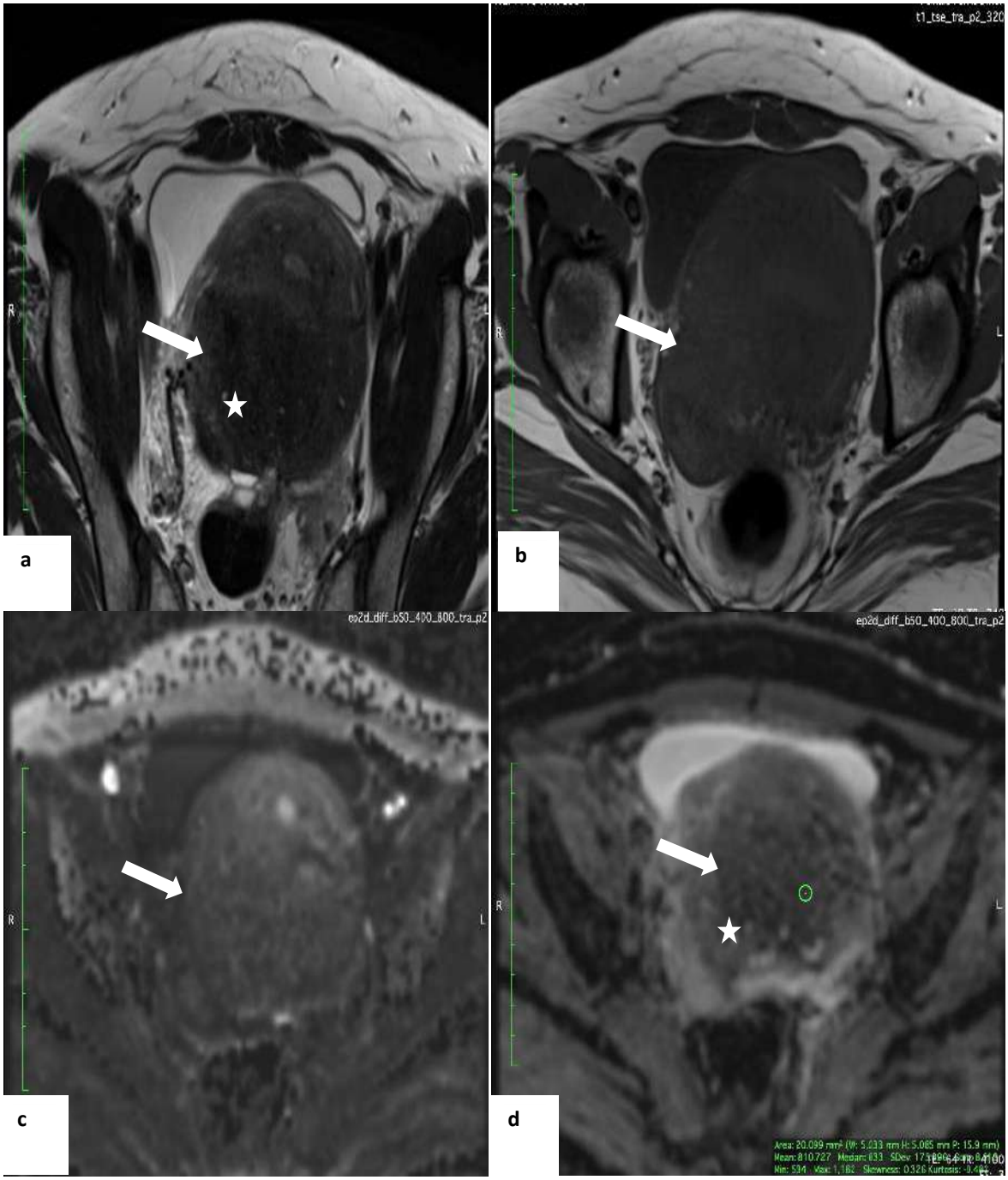
ADENOMYOSIS

Picture 9: A 52 year old female presented with pain in abdomen on and off since the past couple of months(patient no. 19 as in the masterchart).On MRI there was a large ill- defined intramural area(white arrow in images) appearing (a) hypointense on T2WI obl with subendometrial cysts(white star) and thickened endomyometrial junction measuring upto 33mm (b)appearing isointense on T1WI tra (c)showing no diffusion restriction on DWI tra and (d)ADC tra images



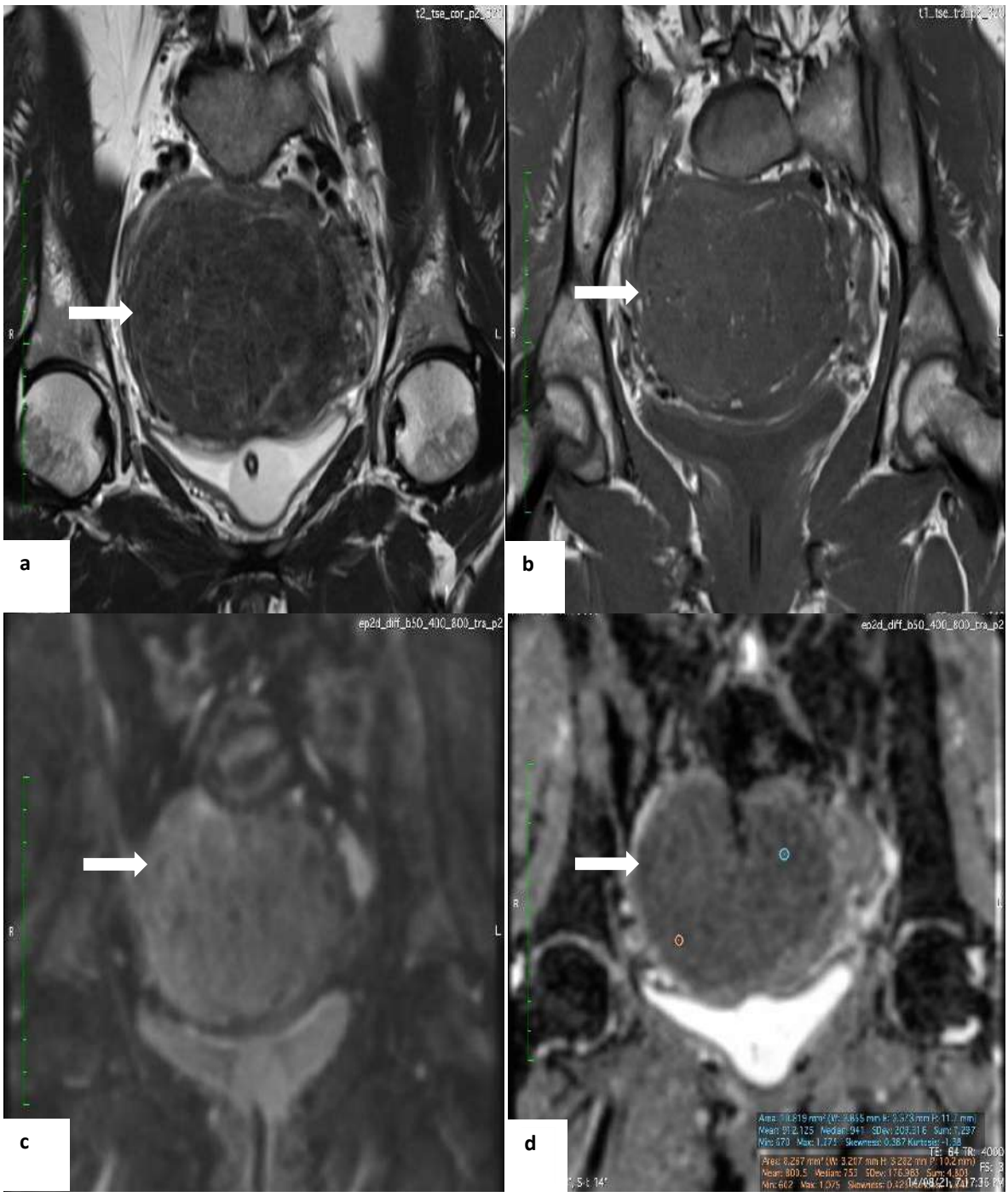
ADENOMYOMA

Picture 10: A 39 year old female presented with pain in abdomen and abnormal uterine bleeding (patient no. 21 as in the masterchart).On MRI there was a large ill- defined intramural lesion(white arrow in images) appearing (a) hypointense on T2WI obl with subendometrial cysts (star) and thickened endomyometrial junction (b)appearing isointense on T1WI tra (c)showing no diffusion restriction on DWI tra and (d)ADC tra images



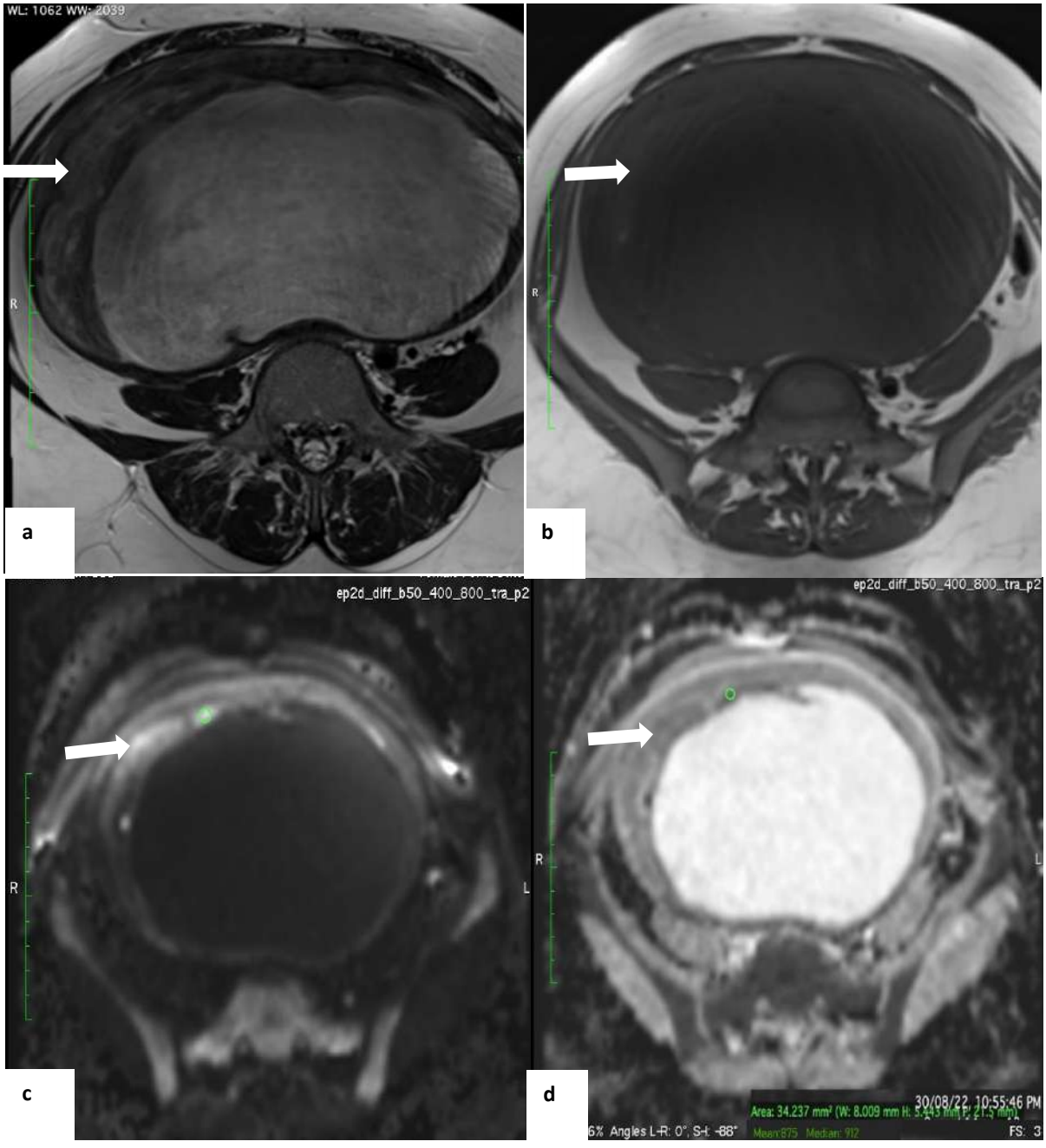
FIBROID WITH HYALINE CHANGE

Picture 11: A 47 year old female presented with irregular menstrual cycles and abdominal pain since the past 5 months (patient no. 6 as in the masterchart) on MRI showed a large well defined (white arrow in images) lobulated intramural lesion appearing (a) hypointense on T2WI cor(b) isointense on T1WI cor and (c) showed no diffusion restriction on DWI and (d)ADC tra images



MYXOID LEIOMYOSARCOMA

Picture 12: A 28 year old female presented with irregular menstrual cycles, abdominal distension and abdominal pain since the past 3 months (patient no. 27 as in the masterchart). MRI revealed a large well defined lobulated intramural lesion showing peripheral (white arrow in images) (a) heterogeneously hyperintense area on T2WI tra (b) appearing isointense on T1WI tra and (c) showing mild diffusion restriction on DWI tra and (d)ADC tra images (white arrow in images)



S.NO	MRD	INITIALS	AGE	PRESENTING COMPLAINTS				MENSTRUAL HISTORY		BIOCHEMICAL ANALYSIS									PAP SMEAR EXAM(if done)	LESION 1										
																				USG EXAM		MRI FINDINGS								
																								location of lesion						
				abdominal heaviness	abdominal pain	abdominal distension	abnormal uterine bleeding	regular /irregular/ absent	ca/other	diabetes mellitus	hypertension	hypothroididsm	Hb(12-17gm/dl)	tlc(4-10x 10-3/ul)	plt (10-3/ul)	creatinine(0.5-1.1mg/dl)	ca 125(0-35u/ml)	ca 19-9	neutro(40-70%)		uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2	
																													SI(signal intensity)	other features
1	346895	RJ	47	yes	yes	no	yes	absent	no	yes	yes	-	9.1	6.5	234	0.6	no	no	60.2	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	subserosal	fundus	posterior myometrium	6	isointense	no	heterogenously hyperintense	whorled pattern
2	1130248	NK	44	yes	yes	yes	yes	irregular	no	-	-	yes	8.5	11	177	0.6	no	no	67.4	-	bulky uterus with lobulated outline and fibroid	-	lipoleimyoma	-	loss of signal on fat sat	submucosal	posterior cervical lip	-	9	hyperintense	no	heterogenously hyperintense	-
3	1137434	SK	41	no	no	no	yes	irregular	no	-	-	yes	9.2	11.3	302	0.7	no	no	59.7	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	subserosal	-	posterior myometrium	7	isointense	no	heterogenously hyperintense	whorled pattern
4	1205949	AK	40	no	no	no	yes	irregular	no	-	-	yes	10.7	12.4	620	1.2	no	no	73	negative for malignancy	-	endomyometrial junction thickening - adenomyosis	adenomyosis	14	-	intramural	-	posterior myometrium	-	isointense	no	hypointense	subendometrial cysts
5	1226995	RG	50	no	no	no	yes	irregular	no	yes	yes	-	12	5.1	150	0.5	no	no	61	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	intramural	-	anterior myometrium	3.1	isointense	no	heterogenously hyperintense	whorled pattern
6	1145741	NPK	47	no	yes	yes	yes	irregular	no	yes	-	yes	12.4	0.3	269	0.7	no	no	72.8	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	subserosal	right lateral wall	-	9	isointense	no	isointense	whorled pattern
7	1170572	AK	31	yes	yes	yes	yes	irregular	no	-	-	-	9.2	11.4	120	0.4	no	no	91	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	subserosal	-	anterior myometrium	21	heterogenously isointense	no	hypointense	whorled pattern
8	1173567	KK	58	no	yes	no	yes	absent	-	yes	-	-	12.8	12.2	11	0.6	no	no	66	negative for malignancy	small fibroid	-	fibroid with cystic changes	-	-	intramural	-	anterior myometrium	2.5	heterogenously isointense	no	hypointense	whorled pattern
9	1193615	SJ	45	no	no	no	yes	regular	-	-	yes	-	10.7	6.3	280	0.7	no	no	88	negative for malignancy	small fibroid	-	fibroid with cystic changes	-	-	intramural	-	anterior myometrium	3.8	heterogenously isointense	no	hypointense	cystic changes

S.NO	MRD	LESION 2																														
		FOLLOW UP						USG EXAM		MRI FINDINGS																	FOLLOW UP		USG EXAM				
													location of lesion						characteristics on t2													
		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal /intramural/ submucosal	other	anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen
1	346895	diffusion restriction present	867	-	1279	hysterectomy with bilateral salpingooophorectomy	fibroid with hyaline change	-	-	fibroid	-	-	intramural	-	anterior myometrium	4.7	isointense	-	heterogenously hyperintense	whorled pattern	diffusion restriction absent	678	-	-	hysterectomy with bilateral salpingooophorectomy	fibroid with hyaline change	-	-	-	-	-
2	1130248	diffusion restriction absent	1538	-	1661	hysterectomy with bilateral salpingooophorectomy	lipoleiomyoma	-	endomyometrial junction thickening - adenomyosis	adenomyosis	13.5	-	intramural	-	anterior myometrium	-	isointense	no	hypointense	subendometrial cysts	diffusion restriction absent	898	-	-	hysterectomy with bilateral salpingooophorectomy	adenomyosis	-	-	-	-	-
3	1137434	diffusion restriction absent	398	-	1349	myomectomy	usual leiomyoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	1205949	diffusion restriction absent	1189	-	1210	hysterectomy with bilateral salpingooophorectomy	adenomyosis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	1226995	diffusion restriction absent	849	-	1483	hysterectomy with bilateral salpingooophorectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	1145741	diffusion restriction absent	348	-	1169	hysterectomy with bilateral salpingooophorectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	1170572	diffusion restriction absent	1745	-	2110	myomectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	1173567	diffusion restriction absent	645	-	2428	hysterectomy with bilateral salpingooophorectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	1193615	diffusion restriction absent	981	-	1420	hysterectomy with bilateral salpingooophorectomy	fibroid with hyaline change	-	endomyometrial junction thickening - adenomyosis	adenomyosis	21	-	intramural	-	posterior myometrium	-	isointense	no	hypointense	subendometrial cysts	diffusion restriction absent	1007	-	-	hysterectomy with bilateral salpingooophorectomy	adenomyosis	-	-	fibroid with cystic changes	-	-

S.NO	MRD	LESION 3														LESION 4																			
		MRI FINDINGS												FOLLOW UP		USG EXAM		MRI FINDINGS																		
		location of lesion			size of the lesion(cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	location of lesion			size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable				
		subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium				SI(signal intensity)	other features												subserosal/ intramural/ submucosal	other	anterior myometrium/posterior myometrium				SI(signal intensity)	other features							
1	346895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1130248	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1137434	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	1205949	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	1226995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	1145741	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	1170572	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	1173567	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	1193615	submucosal	-	posterior myometrium	1.9	heterogenously isointense	-	hypointense	cystic changes	diffusion restriction absent	882	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	LESION 5																								
			FOLLOW UP		USG EXAM		MRI FINDINGS																		FOLLOW UP	
										location of lesion						characteristics on t2									
		adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis
1	346895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1130248	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1137434	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	1205949	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	1226995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	1145741	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	1170572	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	1173567	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	1193615	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	INITIALS	AGE	PRESENTING COMPLAINTS				MENSTRUAL HISTORY		BIOCHEMICAL ANALYSIS									PAP SMEAR EXAM(if done)	LESION 1										
																				USG EXAM		MRI FINDINGS								
																								location of lesion					characteristics on t2	
				abdominal heaviness	abdominal pain	abdominal distension	abnormal uterine bleeding	regular /irregular/ absent	ca/other	diabetes mellitus	hypertension	hypothroididsm	Hb(12-17gm/dl)	tlc(4-10x 10-3/ul)	plt (10-3/ul)	creatinine(0.5-1.1mg/dl)	ca 125(0-35u/ml)	ca 19-9	neutro(40-70%)		uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features
10	1194404	RK	51	no	yes	no	yes	irregular	no	-	-	-	10.8	12.9	286	0.59	no	no	61	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	subserosal	fundus	-	5.3	heterogenously isointense	no	hypointense	cystic changes
11	1197810	HS	41	no	no	no	yes	irregular	no	-	yes	-	11.9	7	204	0.61	no	no	67	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	intramural	-	posterior myometrium	4.2	isointense	heterogenous enhancement	hypointense	cystic changes
12	1297583	NK	63	no	no	no	yes	absent	no	-	yes	-	13.1	8.4	110	0.59	no	no	71.3	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	intramural	-	posterior myometrium	5.2	isointense	no	heterogenously hyperintense	whorled pattern
13	232016	VLS	45	no	yes	no	yes	irregular	no	-	-	-	9.9	7	224	0.68	no	no	72.7	-	small fibroid	-	fibroid	-	-	intramural	-	anterior myometrium	3	isointense	no	hypointense	cystic changes
14	1322696	M	41	no	yes	no	yes	irregular	no	-	-	-	9.8	10.2	239	0.67	no	no	77.4	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	subserosal	right lateral wall	-	6	isointense	no enhancement	hypointense	cystic changes
15	1316595	SK	37	no	yes	no	yes	regular	-	-	-	-	13	6.5	197	0.57	no	no	54.6	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	no suppression on fat sat	subserosal	-	posterior myometrium	6.9	isointense	no	hypointense	cystic changes
16	1319238	SB	49	yes	no	no	no	irregular	no	-	-	yes	9.2	12.3	609	0.54	no	no	84.3	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	intramural	right lateral wall	-	3.9	isointense	no	hypointense	whorled pattern and cystic changes
17	1304415	SPK	25	yes	no	yes	yes	regular	no	-	-	-	11.1	7	328	0.6	no	no	55	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	subserosal	-	anterior myometrium	10.5	isointense	no enhancement	hypointense	whorled pattern and cystic changes
18	1304360	IS	37	no	yes	no	yes	irregular	no	-	yes	-	10.7	5.6	162	0.66	no	no	66	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	subserosal	-	posterior myometrium	6.9	isointense	no	hypointense	whorled pattern and cystic changes

S.NO	MRD	LESION 2																														
		FOLLOW UP						USG EXAM		MRI FINDINGS																FOLLOW UP		USG EXAM				
		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	location of lesion			size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen
													subserosal /intramural/ submucosal	other	anterior myometrium/ posterior myometrium				SI(signal intensity)	other features											
10	1194404	diffusion restriction present	1004	-	1057	total abdominal hysterectomy	fibroid with lymphoid infilterate	-	-	fibroid	-	-	intramural	-	anterior myometrium	1.1	heterogenously isointense	no	hypointense	cystic changes	diffusion restriction absent	1070	-	-	total abdominal hysterectomy	fibroid with hyaline change	-	-	-	-	-
11	1197810	diffusion restriction absent	940	-	1369	hysterectomy with bilateral salpingooop herectomy	fibroid with hyaline change	-	-	fibroid	-	-	intramural	-	anterior myometrium	1	isointense	no	hypointense	cystic changes	diffusion restriction absent	1140	-	-	hysterectomy with bilateral salpingooop herectomy	fibroid with hyaline change	-	-	-	-	-
12	1297583	diffusion restriction absent	399	heterogenous enhancement	2263	hysterectomy with bilateral salpingooop herectomy	fibroid with hyaline change	-	-	fibroid with cystic changes	-	-	intramural	-	anterior myometrium	3.7	isointense	no	hypointense	cystic changes	diffusion restriction absent	466	-	-	hysterectomy with bilateral salpingooop herectomy	fibroid with hyaline change	-	-	-	-	-
13	232016	diffusion restriction absent	861	-	1147	hysterectomy with bilateral salpingooop herectomy	fibroid with hyaline change	-	endomyometrial junction thickenening - adenomyosis	adenomyosis	23	-	intramural	-	posterior myometrium	-	isointense	no	hypointense	subendometrial cysts	diffusion restriction absent	1062	-	-	hysterectomy with bilateral salpingooop herectomy	adenomyosis	-	-	-	-	-
14	1322696	diffusion restriction absent	603	-	1687	myomectomy	fibroid with hyaline change	-	-	fibroid with cystic changes	-	-	intramural	-	anterior myometrium	2.9	isointense	no	hypointense	cystic changes	diffusion restriction absent	735	-	-	hysterectomy with bilateral salpingooop herectomy	fibroid with hyaline change	-	-	-	-	-
15	1316595	diffusion restriction absent	1410	no enhancement	1339	hysterectomy with bilateral salpingooop herectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	1319238	diffusion restriction absent	478	-	1531	hysterectomy with bilateral salpingooop herectomy	fibroid with hyaline change	-	-	fibroid with cystic changes	-	-	intramural	-	anterior myometrium	2.2	isointense	no	hypointense	whorled pattern and cystic changes	diffusion restriction absent	619	-	-	hysterectomy with bilateral salpingooop herectomy	fibroid with hyaline change	-	-	-	-	-
17	1304415	diffusion restriction absent	871	-	1326	myomectomy	fibroid with hyaline change	-	-	fibroid with cystic changes	-	-	intramural	-	anterior myometrium	2.1	isointense	no	hypointense	whorled pattern and cystic changes	diffusion restriction absent	676	-	-	myomectomy	fibroid with hyaline change	-	-	-	-	-
18	1304360	diffusion restriction absent	781	no enhancement	1231	myomectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	LESION 3														LESION 4																			
		MRI FINDINGS												FOLLOW UP		USG EXAM		MRI FINDINGS																		
		location of lesion			size of the lesion(cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	location of lesion			size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable				
		subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium				SI(signal intensity)	other features												subserosal/ intramural/ submucosal	other	anterior myometrium/posterior myometrium				SI(signal intensity)	other features						
10	1194404	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	1197810	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	1297583	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	232016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	1322696	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	1316595	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	1319238	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	1304415	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	1304360	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	LESION 5																								
			FOLLOW UP		USG EXAM		MRI FINDINGS																		FOLLOW UP	
										location of lesion						characteristics on t2									
		adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis
10	1194404	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	1197810	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	1297583	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	232016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	1322696	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	1316595	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	1319238	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	1304415	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	1304360	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	INITIALS	AGE	PRESENTING COMPLAINTS				MENSTRUAL HISTORY		BIOCHEMICAL ANALYSIS									PAP SMEAR EXAM(if done)	LESION 1										
																				USG EXAM		MRI FINDINGS								
																							location of lesion						characteristics on t2	
				abdominal heaviness	abdominal pain	abdominal distension	abnormal uterine bleeding	regular /irregular/ absent	ca/other	diabetes mellitus	hypertension	hypothroididsm	Hb(12-17gm/dl)	tlc(4-10x 10-3/ul)	plt (10-3/ul)	creatinine(0.5-1.1mg/dl)	ca 125(0-35u/ml)	ca 19-9	neutro(40-70%)		uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features
19	1291459	RR	52	no	no	yes	no	absent	no	yes	-	-	8.1	7.5	270	0.48	no	no	70	negative for malignancy	-	endomyometrial junction thickening - adenomyosis	adenomyosis	33	-	intramural	-	posterior myometrium	-	isointense	no	hypointense	subendometrial cysts
20	1283079	AK	35	yes	yes	yes	yes	irregular	no	-	-	-	2.3	4.5	429	0.48	no	no	57	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	submucosal	-	posterior myometrium	12	isointense	no	isointense to hypointense	whorled pattern and cystic changes
21	465151	S	39	no	yes	no	yes	regular	no	-	-	-	10.5	11	214	0.6	652	no	76.9	-	bulky uterus with lobulated outline and fibroid	-	adenomyoma	25	-	intramural	-	posterior myometrium	7	isointense	no	hypointense	subendometrial cysts
22	352860	A	38	yes	no	yes	yes	regular	-	-	-	-	9.2	6.7	216	0.6	no	no	81.3	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	intramural	left lateral wall	-	16.7	isointense	no	isointense	whorled pattern and cystic changes
23	1283961	S	36	yes	no	no	no	irregular	no	-	-	-	7.5	5.8	335	0.5	no	no	63	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	intramural	left lateral wall	-	14.6	isointense	no	hypointense	whorled pattern and cystic changes
24	30357	MK	53	yes	yes	no	no	absent	-	-	yes	-	13.8	10.8	302	0.79	no	no	74.7	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	intramural	-	posterior myometrium	1	isointense	no	hypointense	cystic changes
25	1274968	RS	35	no	no	no	no	regular	no	-	-	-	3.7	8.1	202	0.58	92.9	no	67.5	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	intramural	left lateral wall	-	5.8	isointense	no	hypointense	cystic changes
26	1269364	AS	57	no	no	no	yes	absent	no	-	-	-	11	5	272	0.68	no	no	66.8	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	intramural	-	posterior myometrium	6.3	isointense	no	hypointense	cystic changes
27	1368809	AS	28	yes	yes	yes	yes	regular	no	-	-	-	5.6	6.9	447	0.5	no	no	57.7	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	intramural	-	posterior myometrium	18	isointense	no	hypointense	cystic changes

S.NO	MRD	LESION 2																														
						FOLLOW UP		USG EXAM		MRI FINDINGS																	FOLLOW UP		USG EXAM				
													location of lesion						characteristics on t2													
		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal /intramural/ submucosal	other	anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen
19	1291459	diffusion restriction absent	949	-	1298	hysterectomy with bilateral salpingooopherectomy	adenomyosis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	1283079	diffusion restriction absent	781	-	1413	myomectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	465151	diffusion restriction absent	755	-	975	myomectomy	adenomyoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	352860	diffusion restriction absent	728	-	1617	myomectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	1283961	diffusion restriction absent	805	-	2276	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid	-	-	intramural	-	anterior myometrium	2.7	isointense	no	hypointense	cystic changes	diffusion restriction absent	840	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-
24	30357	diffusion restriction absent	779	-	2316	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	1274968	diffusion restriction absent	1240	-	1907	myomectomy	fibroid with hyaline change	-	-	fibroid	-	-	subserosal	-	anterior myometrium	2.2	isointense	no	hypointense	cystic changes	diffusion restriction absent	922	-	-	myomectomy	fibroid with hyaline change	-	-	-	-	-
26	1269364	diffusion restriction absent	984	-	1555	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	1368809	diffusion restriction present	875	-	1388	myomectomy	myxoid leiomyosarcoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	LESION 3														LESION 4																				
		MRI FINDINGS												FOLLOW UP		USG EXAM		MRI FINDINGS																			
		location of lesion			size of the lesion(cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	location of lesion			size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable					
		subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium				SI(signal intensity)	other features												subserosal/ intramural/ submucosal	other	anterior myometrium/posterior myometrium				SI(signal intensity)	other features							
19	1291459	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	1283079	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	465151	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	352860	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	1283961	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	30357	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	1274968	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	1269364	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	1368809	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	LESION 5																								
			FOLLOW UP		USG EXAM		MRI FINDINGS																		FOLLOW UP	
										location of lesion						characteristics on t2									
		adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis
19	1291459	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	1283079	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	465151	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	352860	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	1283961	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	30357	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	1274968	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	1269364	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	1368809	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	INITIALS	AGE	PRESENTING COMPLAINTS				MENSTRUAL HISTORY		BIOCHEMICAL ANALYSIS									PAP SMEAR EXAM(if done)	LESION 1										
																				USG EXAM		MRI FINDINGS								
																							location of lesion						characteristics on t2	
				abdominal heaviness	abdominal pain	abdominal distension	abnormal uterine bleeding	regular /irregular/ absent	ca/other	diabetes mellitus	hypertension	hypothroididsm	Hb(12-17gm/dl)	tlc(4-10x 10-3/ul)	plt (10-3/ul)	creatinine(0.5-1.1mg/dl)	ca 125(0-35u/ml)	ca 19-9	neutro(40-70%)		uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features
28	1270078	DJ	36	no	no	no	yes	regular	-	-	-	-	11.5	5.2	190	0.76	no	no	41.5	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	submucosal	left lateral wall	-	3.3	isointense	no	hypointense	cystic changes
29	1262024	JPK	60	no	no	yes	no	absent	-	-	yes	-	12.2	8.2	287	0.57	no	no	54.2	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	intramural	-	anterior myometrium	1.4	isointense	no	hypointense	whorled pattern
30	793698	SK	52	no	no	yes	no	absent	no	-	yes	-	10.9	6.8	277	0.67	no	no	49.6	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	intramural	-	posterior myometrium	1.9	isointense	no	hypointense	cystic changes
31	534174	VG	45	no	no	yes	yes	absent	-	-	-	-	11	7	332	0.7	no	no	50.2	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	intramural	fundus	-	2.1	isointense	heterogenous enhancement	isointense to hypointense	-
32	1236157	AK	50	no	yes	no	yes	absent	-	-	-	-	8.4	12.1	410	0.58	101.5	no	90.9	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	adenomyoma	18	-	submucosal	fundus	-	8.5	isointense	no	hypointense	subendometrial cysts and nodules and striations
33	1409929	B	46	no	no	yes	yes	absent	-	-	-	-	13.6	6.4	155	0.66	13.5	no	77.6	negative for malignancy	-	endomyometrial junction thickening - adenomyosis	adenomyosis	13	-	intramural	-	-	-	isointense	no	hypointense	subendometrial cysts
34	4250	MK	55	no	yes	no	no	absent	no	-	yes	-	10.4	13.3	294	0.63	no	no	66.5	negative for malignancy	bicornuate uterus with bulky left cornua and fibroid	-	fibroid	-	-	intramural	bicornuate uterus,left uetrine horn	-	4	isointense	no	hypointense	cystic changes
35	1402980	BWS	29	no	no	yes	no	regular	-	-	-	-	12.4	8.6	300	0.64	no	no	55.8	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	subserosal	-	-	10.1	isointense	no	hypointense	cystic changes
36	1397104	CK	40	no	no	yes	no	irregular	no	-	-	-	9.7	8.8	444	0.68	no	no	65.7	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	submucosal	-	anterior myometrium	4.7	isointense	no	hypointense	whorled pattern

S.NO	MRD	LESION 2																														
		FOLLOW UP						USG EXAM		MRI FINDINGS																FOLLOW UP		USG EXAM				
													location of lesion					characteristics on t2													
		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal /intramural/ submucosal	other	anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen
28	1270078	diffusion restriction absent	829	-	1456	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	1262024	diffusion restriction absent	738	-	1647	hysterectomy with bilateral salpingooopherectomy	usual leiomyoma	-	-	fibroid	-	-	intramural	right lateral wall	-	1.1	isointense	heterogeneous enhancement	hypointense	whorled pattern	diffusion restriction absent	801	-	-	hysterectomy with bilateral salpingooopherectomy	usual leiomyoma	-	endomyometrial junction thickening - adenomyosis	adenomyosis	14	-
30	793698	diffusion restriction absent	927	heterogenous enhancement	1264	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid	-	-	intramural	fundus	-	1.1	isointense	no	hypointense	cystic changes	diffusion restriction absent	684	heterogenous enhancement	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-
31	534174	diffusion restriction present	334	-	1190	hysterectomy with bilateral salpingooopherectomy	cellular fibroid	-	-	fibroid	-	-	subserosal	-	anterior myometrium	3.3	isointense	no	hypointense	whorled pattern	diffusion restriction absent	890	-	-	hysterectomy with bilateral salpingooopherectomy	usual leiomyoma	-	endomyometrial junction thickening - adenomyosis	adenomyosis	15	-
32	1236157	diffusion restriction absent	894	-	1487	hysterectomy with bilateral salpingooopherectomy	adenomyoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	1409929	diffusion restriction absent	954	-	1674	hysterectomy with bilateral salpingooopherectomy	adenomyosis	-	-	fibroid	-	-	intramural	-	posterior myometrium	1.1	isointense	no	hypointense	cystic changes	diffusion restriction absent	831	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid	-	-
34	4250	diffusion restriction absent	163	-	1262	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid	-	-	intramural	bicornuate ,right uterine horn	-	1	isointense	no	hypointense	cystic changes	diffusion restriction absent	714	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-
35	1402980	diffusion restriction absent	790	-	1133	myomectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	1397104	diffusion restriction absent	882	-	1582	hysterectomy with bilateral salpingooopherectomy	usual leiomyoma	-	-	fibroid	-	-	other	right lateral wall	-	1	isointense	no	hypointense	cystic changes	diffusion restriction absent	814	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-

S.NO	MRD	LESION 3													LESION 4																			
		MRI FINDINGS											FOLLOW UP		USG EXAM		MRI FINDINGS																	
		location of lesion			size of the lesion(cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	location of lesion			size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable			
		subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium				SI(signal intensity)	other features												subserosal/ intramural/ submucosal	other	anterior myometrium/posterior myometrium				SI(signal intensity)	other features						
28	1270078	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	1262024	intramural	-	posterior myometrium	-	isointense	heterogeneous enhancement	hypointense	subendometrial cysts	diffusion restriction absent	876	-	-	hysterectomy with bilateral salpingooopherectomy	adenomyosis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	793698	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	534174	intramural	-	-	-	isointense	no	hypointense	subendometrial cysts	diffusion restriction absent	744	heterogenous enhancement	-	hysterectomy with bilateral salpingooopherectomy	adenomyosis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	1236157	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	1409929	other	-	anterior myometrium	1	isointense	no	hypointense	cystic changes	diffusion restriction absent	795	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	4250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	1402980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	1397104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	LESION 5																								
			FOLLOW UP		USG EXAM		MRI FINDINGS																		FOLLOW UP	
										location of lesion						characteristics on t2									
		adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis
28	1270078	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	1262024	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	793698	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	534174	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	1236157	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	1409929	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	4250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	1402980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	1397104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	INITIALS	AGE	PRESENTING COMPLAINTS				MENSTRUAL HISTORY		BIOCHEMICAL ANALYSIS									PAP SMEAR EXAM(if done)	LESION 1										
																				USG EXAM		MRI FINDINGS									
																							location of lesion						characteristics on t2	
				abdominal heaviness	abdominal pain	abdominal distension	abnormal uterine bleeding	regular /irregular/ absent	ca/other	diabetes mellitus	hypertension	hypothroididsm	Hb(12-17gm/dl)	tlc(4-10x 10-3/ul)	plt (10-3/ul)	creatinine(0.5-1.1mg/dl)	ca 125(0-35u/ml)	ca 19-9	neutro(40-70%)		uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features
37	1374453	AK	48	no	no	yes	no	absent	no	-	-	-	9.1	11.5	203	0.79	15.8	no	52.9	-	-	endomyometrial junction thickening - adenomyosis	adenomyosis	26	-	subserosal	-	posterior myometrium	-	isointense	no	hypointense	subendometrial cysts
38	1384846	PK	42	yes	no	yes	yes	irregular	-	-	-	-	12.9	19.5	288	0.54	96.5	no	88	-	-	endomyometrial junction thickening - adenomyosis	adenomyosis	17	-	intramural	-	posterior myometrium	-	isointense	no	hypointense	subendometrial cysts
39	1359926	SS	49	yes	no	no	yes	absent	-	-	-	-	5	5.7	323	0.54	13.9	no	67.4	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	submucosal	-	posterior myometrium	4.2	isointense	no	hypointense	cystic changes
40	1335694	KK	50	no	no	yes	yes	absent	-	-	-	yes	11.4	7.7	151	0.69	no	no	64	-	-	endomyometrial junction thickening - adenomyosis	adenomyosis	16.7	-	intramural	-	posterior myometrium	-	isointense	no	hypointense	subendometrial cysts
41	1335955	JK	49	no	no	yes	no	absent	-	-	-	-	9.5	11.3	231	0.8	no	no	79.2	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	submucosal	-	anterior myometrium	4.8	hypointense	no	heterogenously hyperintense	whorled pattern
42	1334700	J	57	no	yes	no	no	no	no	-	yes	-	12.4	5.6	156	0.38	no	no	63.3	negative for malignancy	-	endomyometrial junction thickening - adenomyosis	adenomyosis	24	-	intramural	right lateral wall	-	1.2	isointense	no	hypointense	subendometrial cysts
43	1344651	MJ	44	yes	no	yes	yes	aaaab	no	-	-	-	12	8.9	257	0.76	16.5	no	57.8	negative for malignancy	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	subserosal	right lateral wall	posterior myometrium	12.8	isointense	no	hypointense	cystic changes
44	1340627	JK	23	no	yes	no	yes	regular	-	-	-	-	8.1	10.9	265	0.52	no	no	82.9	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	intramural	-	posterior myometrium	4.5	isointense	no	isointense to hypointense	-
45	1021819	MS	49	no	no	yes	no	absent	-	yes	-	-	8.6	11.5	7	295	0.58	no	54.5	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	subserosal	-	anterior myometrium	3.3	isointense	no	hypointense	cystic changes

S.NO	MRD	LESION 2																														
						FOLLOW UP		USG EXAM		MRI FINDINGS																	FOLLOW UP		USG EXAM				
													location of lesion						characteristics on t2													
		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal /intramural/ submucosal	other	anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen
37	1374453	diffusion restriction absent	836	-	1673	hysterectomy with bilateral salpingooopherectomy	adenomyosis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	1384846	diffusion restriction absent	938	-	1235	hysterectomy with bilateral salpingooopherectomy	adenomyosis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	1359926	diffusion restriction absent	907	-	1531	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change and hyaline necrosis	-	endomyometrial junction thickening - adenomyosis	adenomyosis	15	-	intramural	-	-	-	isointense	no	hypointense	cystic changes	diffusion restriction present	773	-	-	-	fibroid with hyaline change	-	-	fibroid with cystic changes	-	-
40	1335694	diffusion restriction absent	741	-	1222	hysterectomy with bilateral salpingooopherectomy	adenomyosis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	1335955	diffusion restriction absent	1471	-	1248	hysterectomy with bilateral salpingooopherectomy	usual leiomyoma	-	-	fibroid with cystic changes	-	-	intramural	-	anterior myometrium	0.9	isointense	no	heterogenously hyperintense	cystic changes	diffusion restriction absent	648	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid with cystic changes	-	-
42	1334700	diffusion restriction absent	309	-	1289	hysterectomy with bilateral salpingooopherectomy	adenomyosis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	1344651	diffusion restriction absent	980	-	1324	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid with cystic changes	-	-	intramural	-	anterior myometrium	3	isointense	no	hypointense	cystic changes	diffusion restriction absent	889	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-
44	1340627	diffusion restriction present	328	-	1442	myomectomy	cellular fibroid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	1021819	diffusion restriction present	742	-	1243	myomectomy	fibroid with hyaline change	-	-	fibroid	-	-	other	fundus	-	5.2	isointense	no	hypointense	cystic changes	diffusion restriction absent	378	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid with cystic changes	-	-

S.NO	MRD	LESION 3														LESION 4																			
		MRI FINDINGS												FOLLOW UP		USG EXAM		MRI FINDINGS																		
		location of lesion			size of the lesion(cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	location of lesion			size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable					
		subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium				SI(signal intensity)	other features												subserosal/ intramural/ submucosal	other	anterior myometrium/posterior myometrium				SI(signal intensity)	other features							
37	1374453	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	1384846	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	1359926	intramural	left lateral wall	-	7.3	isointense	no	hypointense	cystic changes	diffusion restriction absent	611	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change and hyaline necrosis	-	-	fibroid	-	-	intramural	-	posterior myometrium	4.1	isointense	no	hypointense	cystic changes	diffusion restriction absent	308	-					
40	1335694	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	1335955	itramural	left lateral wall	-	2.5	isointense	no	hypointense	cystic changes	diffusion restriction absent	294	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid	-	-	intramural	-	posterior myometrium	11.5	isointense	no	hypointense	cystic changes	diffusion restriction absent	638	-					
42	1334700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	1344651	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	1340627	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	1021819	subserosal	-	anterior myometrium	3.9	isointense	no	hypointense	cystic changes	diffusion restriction absent	508	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid	-	-	intramural	left lateral wall	-	3.4	isointense	no	hypointense	cystic changes	diffusion restriction absent	565	-					

S.NO	MRD	LESION 5																							
			FOLLOW UP		USG EXAM		MRI FINDINGS																	FOLLOW UP	
										location of lesion						characteristics on t2								
		adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis
37	1374453	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	1384846	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	1359926	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid	-	-	other	left lateral wall	-	5.2	isointense	no	hypointense	cystic changes	diffusion restriction absent	421	-	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change
40	1335694	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	1335955	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	1334700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	1344651	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	1340627	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	1021819	-	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	endomyometrial junction thickenening - adenomyosis	adenomyosis	19.8	-	intramural	-	posterior myometrium	-	isointense	no	hypointense	subendometrial cysts	diffusion restriction absent	890	-	-	hysterectomy with bilateral salpingooopherectomy	adenomyosis

S.NO	MRD	INITIALS	AGE	PRESENTING COMPLAINTS				MENSTRUAL HISTORY		BIOCHEMICAL ANALYSIS									PAP SMEAR EXAM(if done)	LESION 1										
																				USG EXAM		MRI FINDINGS								
																								location of lesion					T1 post contrast findings if applicable	characteristics on t2	
				abdominal heaviness	abdominal pain	abdominal distension	abnormal uterine bleeding	regular /irregular/ absent	ca/other	diabetes mellitus	hypertension	hypothroididsm	Hb(12-17gm/dl)	tlc(4-10x 10-3/ul)	plt (10-3/ul)	creatinine(0.5-1.1mg/dl)	ca 125(0-35u/ml)	ca 19-9	neutro(40-70%)		uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/posterior myometrium	size of the lesion (cm)	SI ON t1		SI(signal intensity)	other features
46	1032243	NB	39	no	no	no	no	irregular	-	-	-	yes	11.5	7.8	181	0.58	no	no	67.8	-	small fibroid	-	fibroid	-	-	intramural	-	posterior myometrium	1.1	isointense	no	isointense to hypointense	-
47	1012298	E	25	yes	no	yes	yes	irregular	no	-	-	-	9.5	6.6	290	0.56	no	no	65.5	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	intramural	-	anterior myometrium	8.2	isointense	no	hypointense	whorled pattern and cystic changes
48	1016999	MK	48	no	no	yes	no	absent	no	-	yes	-	10.7	6	451	0.7	no	no	63	-	bulky uterus with lobulated outline and fibroid	-	fibroid with cystic changes	-	-	subserosal	right lateral wall	-	6.2	isointense	no	hypointense	whorled pattern and cystic changes
49	8446	NK	33	no	no	no	no	irregular	no	-	-	-	11	7.4	223	0.6	no	no	55.5	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	intramural	-	anterior myometrium	1.3	isointense	no	hypointense	cystic changes
50	993394	PS	47	no	no	yes	no	irregular	no	yes	-	-	12.8	9.8	316	0.65	no	no	72.5	-	-	endomyometrial junction thickening - adenomyosis	ADENOMYOSIS	13.4	-	intramural	fundus	-	-	isointense	no	hypointense	subendometrial cysts
51	1118103	RR	57	yes	yes	no	no	absent	no	yes	-	yes	10.9	7.4	177	0.48	no	no	86.9	-	bulky uterus with lobulated outline and fibroid	-	fibroid	-	-	intramural	-	anterior myometrium	5.1	isointense	heterogenously enhancing solid component with peripherally enhancing cystic component	heterogenously hyperintense	whorled pattern
52	1189238	DK	52	no	yes	no	yes	absent	-	-	yes	-	12.6	10.8	283	0.5	no	no	67	-	bulky uterus with lobulated outline and fibroid	-	lipoleimyoma	-	-	subserosal	-	posterior myometrium	13.5	isointense	-	isointense solid component	solid-cystic(large multiloculated cystic component)

S.NO	MRD																																
						FOLLOW UP		USG EXAM		MRI FINDINGS																		FOLLOW UP		USG EXAM				
		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	location of lesion: subserosal /intramural/ submucosal	location of lesion: other	location of lesion: anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2: SI(signal intensity)	characteristics on t2: other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen
46	1032243	diffusion restriction present	633	-	1172	hysterectomy with bilateral salpingooopherectomy	cellular fibroid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	1012298	diffusion restriction absent	633	-	1705	myomectomy	fibroid with hyaline change	-	-	fibroid	-	-	intramural	-	posterior myometrium	1.7	isointense	no	hypointense	cystic changes	diffusion restriction absent	812	-	-	myomectomy	fibroid with hyaline change	-	-	-	-	-
48	1016999	diffusion restriction absent	489	-	1110	hysterectomy with bilateral salpingooopherectomy	fibroid with hyaline change	-	-	fibroid	-	-	subserosal	-	anterior myometrium	1	isointense	no	hypointense	whorled pattern	diffusion restriction absent	487	-	-	hysterectomy with bilateral salpingooopherectomy	usual leiomyoma	-	-	fibroid	-	-
49	8446	diffusion restriction absent	926	-	1311	myomectomy	fibroid with hyaline change	-	-	adenomyoma	18	-	intramural	-	posterior myometrium	3.3	isointense	no	hypointense	subendometrial cysts	diffusion restriction absent	879	-	-	myomectomy	adenomyoma	-	-	-	-	-
50	993394	diffusion restriction absent	811	-	1318	hysterectomy with bilateral salpingooopherectomy	adenomyosis	adenomyoma	-	-	intramural	right lateral wall	-	2.1	isointense	no	hypointense	subendometrial cysts	diffusion restriction absent	764	-	-	hysterectomy with bilateral salpingooopherectomy	adenomyoma	-	-	-	-	-	-	-	-
51	1118103	diffusion restriction absent	427	-	3003	hysterectomy with bilateral salpingooopherectomy	usual leiomyoma	-	-	fibroid	-	-	intramural	-	anterior myometrium	1.9	isointense	-	isointense to hypointense	whorled pattern	diffusion restriction absent	568	-	-	hysterectomy with bilateral salpingooopherectomy	usual leiomyoma	-	-	-	-	-
52	1189238	diffusion restriction absent	1441	heterogenously enhancing solid component with peripherally enhancing cystic component	1311	hysterectomy with bilateral salpingooopherectomy	lipoleiomyoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD	LESION 3														LESION 4																			
		MRI FINDINGS												FOLLOW UP		USG EXAM		MRI FINDINGS																		
		location of lesion			size of the lesion(cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	location of lesion			size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	characteristics on t2		DWI	adc values of lesions	post contrast findings if applicable				
		subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium				SI(signal intensity)	other features												subserosal/ intramural/ submucosal	other	anterior myometrium/posterior myometrium				SI(signal intensity)	other features							
46	1032243	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	1012298	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	1016999	intramural	-	posterior myometrium	1.2	isointense	no	hypointense	whorled pattern	diffusion restriction absent	149	-	-	hysterectomy with bilateral salpingoopherectomy	usual leiomyoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49	8446	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	993394	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51	1118103	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52	1189238	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

S.NO	MRD				LESION 5																				
			FOLLOW UP		USG EXAM		MRI FINDINGS																	FOLLOW UP	
										location of lesion						characteristics on t2								
		adc values of normal myometrium	treatment done	histopathological diagnosis	uterus	endomyometrial junction	TYPE OF LESION	EMJ thickness in adenomyosis (mm)	description /other features wherever seen	subserosal/intramural/submucosal	other	anterior myometrium/ posterior myometrium	size of the lesion (cm)	SI ON t1	T1 post contrast findings if applicable	SI(signal intensity)	other features	DWI	adc values of lesions	post contrast findings if applicable	adc values of normal myometrium	treatment done	histopathological diagnosis
46	1032243	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	1012298	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	1016999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49	8446	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	993394	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51	1118103	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52	1189238	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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The Principal,
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Subject: Approval of Plan of Thesis.

This is to inform you that the Faculty of Medical Sciences in its meeting held on 29.10.2021 has approved the plan of thesis of **Aarushi Jain**, a student of your college for **MD Radio-diagnosis** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
Role of diffusion weighted imaging and apparent diffusion coefficient in myometrial pathologies.

Supervisor
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The student has to submit the four copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

109. If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.

110. The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.

ROLE OF DIFFUSION WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN MYOMETRIAL PATHOLOGIES

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED IN

PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MD

In

RADIODIAGNOSIS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

MARCH, 2021

DR. AARUSHI JAIN

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ABSTRACT OF PLAN OF THESIS

Title	ROLE OF DIFFUSION WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN MYOMETRIAL PATHOLOGIES
For the degree of	MD (Radiodiagnosis)
Name of the candidate	Dr. Aarushi Jain
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Co-supervisor(s)	Dr. Kavita Saggar, Professor & Head, Department of Radiodiagnosis, Dayanand Medical College & Hospital Dr. Harpreet Kaur, Professor & Head, Department of Pathology, Dayanand Medical College & Hospital
Institution	Dayanand Medical College and Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Uterine smooth muscle i.e. myometrial pathologies are one of the main indications for female pelvic imaging. Most myometrial pathologies are benign leiomyomas and adenomyosis, which occur in 20–30% of women during their reproductive years. Owing to the difficulties associated with transvaginal needle biopsy for uterine smooth muscle tumors, and differential management protocol based on lesion pathology, preoperative diagnosis is important. Diffusion-weighted imaging (DWI) is an emerging technique used to visualize tissue characteristics based on the diffusion motion of water molecules, known as Brownian motion.

Aim of Study:

1.To study the signal pattern of myometrial pathologies on Diffusion Weighted Imaging(DWI). 2.To study the pattern of Apparent Diffusion Coefficient (ADC) values in different myometrial pathologies

Materials & methods: This will be a prospective study done on all female patients undergoing pelvic MRI in the department of Radiodiagnosis and Imaging at Dayanand medical college and hospital over a period of 1 year.

All patients with myometrial pathologies detected on MR imaging will be included post their written informed consent.

Clinical Significance: The purpose of this study is to investigate the utility of the apparent diffusion coefficient (ADC) in diagnosing myometrial pathologies identified by signal intensity (SI) on T2-weighted imaging (T2WI) and diffusion weighted imaging (DWI), and to determine the correlation between ADC and tumor cell density.

Keywords: Diffusion weighted imaging (DWI), Apparent diffusion coefficient (ADC), Myometrial Carcinoma, Myometrium, Myometrial Lesions, Leiomyoma, Leiomyosarcoma

(Signature) Candidate	(Signature) Co-supervisor	(Signature) Co-supervisor	(Signature) Supervisor	(Signature) Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"ROLE OF DIFFUSION WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN MYOMETRIAL PATHOLOGIES"** exist in the Department of Radiodiagnosis, DMCH, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis is genuine and is collected by the candidate herself under our supervision and guidance.

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APPROVAL PROFORMA
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Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
Dr. Harpreet Kaur (Professor & Head, Pathology)	Mr. R K Sharma (Legal Expert)
Dr. Jaspal Singh (Professor & Head, Surgery)	Dr. Ramit Mahajan (Associate Professor, Gastroenterology)
Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)	Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)
Dr. Gurpreet S Wander (Vice Principal)	Dr. Gurpreet S Wander (Vice Principal & Professor & Head, Cardiology)
	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / No

Dr. Sandeep Puri
Chairperson
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Approved: Yes / ~~No~~

Prof. Arvind Malhotra
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BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

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3	COURSE OF STUDY AND SUBJECT	POST-GRADUATE M.D. IN RADIO-DIAGNOSIS
4	DATE OF ADMISSION OF COURSE	03/07/2020
5	TITLE OF THE TOPIC	“ROLE OF DIFFUSION WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN MYOMETRIAL PATHOLOGIES”

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Fibroids or *leiomyomas* are the most common benign neoplasm of the uterus and arise from the smooth muscle layer and its accompanying connective tissue[1,2]. It is estimated that about 20–40% of women will be diagnosed with fibroids but only a fraction of those will be symptomatic and/or require treatment. Uterine fibroids usually compress the surrounding myometrium, thus creating a pseudo-capsule from which the tumor can easily be enucleated at surgery [3] Treatment is varied and may include myomectomy, uterine artery embolization, and hysterectomy [4].

Adenomyosis is a common benign disorder, with an incidence of 40% or less in extirpated uteri [5]. Pathologically, adenomyosis is ectopic endometrial glands and stroma interdigitating with the underlying myometrium with associated hypertrophy and hyperplasia of smooth muscle [6,7]. It may be diffuse throughout the uterus, or focal, where it is referred to as an adenomyoma. Surgical excision is difficult or impossible because the adenomyotic tissue interdigitates with underlying myometrium. Therefore, hysterectomy remains the definitive treatment for women with symptomatic adenomyosis.It has been reported that between 35% and 80% of adenomyosis uteri are accompanied by fibroids.[8]

Leiomyosarcoma is a rare malignant neoplasm representing approximately 1.3% of uterine malignancies, and <0.13% of smooth muscle tumors of the uterus. It develops from uterine smooth muscle, and clinically, is very similar to leiomyoma and adenomyosis. Differential diagnosis is rendered particularly difficult because endometrial cytology, sampling, and hysteroscopy are not useful with regard to diagnosing leiomyosarcoma[9-11]

Deep infiltrating endometriosis(DIE) is characterized by endometriotic tissue invasion to a depth of more than $5mm^2$. This may result in obliteration of anatomic compartments secondary to fibrosis and adhesions. MRI can have a key role in presurgical mapping of

suspected complex endometriosis, and in advanced cases, can assist in planning gynaecologic surgical approach and the potential need for multispecialty involvement [12]

Ultrasound remains the first line of imaging for the female pelvis with high diagnostic accuracy rates for uterine abnormalities.The shortcomings with this modality include the limited field of view, obscuration of pelvic organs by the presence of bowel gas, inherent limitation dependent on patient size and its dependence on the skill and experience of the operator.

MRI because of its superb soft-tissue contrast and direct multiplanar capabilities can better delineate and characterize normal uterine anatomy and focal and diffuse uterine conditions [2,5] .It is non-invasive, has no risk of radiation, requires no anesthesia and is less operator dependent .The functional capability of MRI has been extremely useful in characterizing,localizing and predicting the aggressiveness of the pathology.[4]

Diffusion weighted imaging (DWI) is a magnetic resonance imaging (MRI) sequence structured on the basis of diffusion (Brownian motion) of water molecules in the extracellular space and is being increasingly used to evaluate the female pelvis. The quantitative parameter acquired from DWI sequence is the apparent diffusion coefficient (ADC) value. The basic factors affecting the ADC values are tissue structures, interactions between the molecules and cellular density. DWI is acquired by the measurement of signal loss after a series of two motion-providing gradient (MPG) pulses with the addition of a 180° refocusing radio frequency pulse to both sides for enhancing the variations of molecular diffusion between tissues. The density of MPG pulses is shown by the b-value, a paramount criterion affecting the signal intensity of the DWI [2-5]. An appropriate b value is necessary for the female pelvic MRI.

DW-MRI is a functional imaging technique that does not require exogenous contrast medium administration [4]. This limits contrast associated side effects and opens the usability of imaging modality.

Generally, dense packed tissues with high cellularity such as cancers

have relatively little extracellular space thus leading to restricted water motion and hence have lower ADC values compared to the benign lesions as well as normal tissue [4]. In standard MRI typical leiomyomas appear as well-demarcated hypointense masses on T2-weighted magnetic resonance (MR) images. However, using MR imaging can make it difficult to distinguish leiomyomas from malignant tumors, because some leiomyomas show hyperintensity on T2-weighted imaging (T2WI). Cellular leiomyoma is composed of dense cellular fascicles of smooth muscle with little intervening collagen[1]. This hypercellular nature and lack of collagenous tissue may contribute to increased signal intensity on T2WI . Edematous degenerations in leiomyomas may show hyperintensity on T2WI[1-2]. Malignant tumors including leiomyosarcomas often show hyper to heterogeneous signal intensity (SI) on T2WI because of correspondence to hemorrhage or necrosis [9-11]

Distinguishing benign from malignant tumors on the basis of routine MR examination is often difficult. On DWI, the increased cellularity may restrict water diffusion and thus decrease ADC. Therefore Diffusion-weighted imaging (DWI) is an emerging technique being used to visualize tissue characteristics based on Brownian motion [4,13-14].

As the treatment of different myometrial lesions differ significantly, it becomes very important to make a specific diagnosis in order to guide patient management. Thus, the use of DWI-MRI, even though falling on the higher cost spectrum, will prove to be cost-effective as it reduces unnecessary surgical procedures by its superior ability to accurately identify and differentiate myometrial lesions.

6.2 REVIEW OF LITERATURE

Jha et al[2014] evaluated the apparent diffusion coefficient (ADC) values in 50 patients with uterine fibroids and 43 patients of adenomyosis. DWI was performed with b factors of 50, 400, and 800 s/mm. ADC ROI measurements were placed over a fibroid, an area of adenomyosis, unaffected normal myometrium, skeletal muscle, and urine. The mean and the standard deviation of the ADC values of the control group were as follows: fibroid 0.64 ± 0.29, adenomyosis 0.86 ± 0.30, myometrium 1.39 ± 0.36, and urine 3.01 ± 0.2 x 10^{-3} mm^2 /s. There was a statistically significant difference among the ADC values of normal myometrium and fibroids ($p < 0.0001$), normal myometrium and adenomyosis ($p < 0.0001$), and fibroids and adenomyosis ($p < 0.001$). Histogram analysis demonstrated less tissue heterogeneity of adenomyosis as compared to fibroids.Their study showed that ADC measurements have the potential to quantitatively differentiate between fibroids and adenomyosis.[8]

Tasaki et al [2014] conducted a retrospective study wherein 168 lesions in 134 cases were reviewed.The study revealed the mean ADC was significantly lower for leiomyosarcomas (0.91x10^3 mm^2/s) than for leiomyoma (1.30 x10^3 mm^2/s; $p< 0.05$), and the mean cell density was significantly higher for leiomyosarcomas (42.9%) than for leiomyomas (20.7%; $p< 0.05$). A weak negative correlation between ADC and tumor cell density was found in all tumors (Spearman R = -0.490; $p< 0.05$). The mean ADC of leiomyoma, excluding cellular leiomyoma, was 1.15x10^3 mm^2 /s, significantly higher than that of leiomyosarcoma ($p = 0.013$) and the mean cell density was 20.70%, again showing a significant difference ($p = 0.018$) The study concluded that ADC may be helpful in differentiating between benign and malignant tumors of the uterine smooth muscle, particularly when the tumors show high SI on T2WI and DWI[1-4,17]

Busard et al [2010] investigated 56 patients with known or suspected endometriosis. Endometriotic lesions as well as (functional) ovarian cysts were analyzed for location, size, and signal intensity on T1, T2,

and DWI. Apparent diffusion coefficient (ADC) values were calculated using b-values of 50, 400, 800, and 1200 s/mm^2 . A total of 110 lesions (62 endometrial cysts and 48 Deep infiltrating endometriosis(DIE)) were detected, 60 of which were large enough to analyze. Mean ADC values of endometrial cysts and functional ovarian cysts were 1.10 x10^{-3} mm^2/s and 2.14x10^{-3} mm^2/s, respectively. Mean ADC values of DIE retrocervical, infiltrating the colon, and bladder were 0.70 x 10^{-3} mm^2 /s, 0.77 x 10^{-3} mm^2 /s, and 0.79 x 10^{-3} mm^2/s, respectively. ADC values of DIE did not show a significant difference between varying pelvic locations (P < 0.63). ADC values were consistently low regardless of the pelvic location of DIE [12].

Sato K, Yuasa N, Fujita M et al [2014] investigated 10 lesions from 5 patients with pelvic leiomyosarcoma and 83 leiomyoma nodules from 76 patients, as identified by postoperative pathological examination (1 autopsy).The leiomyosarcoma lesions were readily apparent via DWI, and presented as intermediate to high-intensity areas in the uterine wall. All low-intensity areas presented as leiomyoma nodules. The mean ADC value for the 10 leiomyosarcoma lesions was 0.791 ± 0.145 ×10^{-3} mm^2/s, significantly lower than that of the leiomyoma nodules that presented with intermediate-intensity areas, 1.472 ± 0.285 ×$10^{-3}$$mm^2$/s (n = 41) (P < .001), and high-intensity areas (1.100 ± 0.343) (n = 9) (P = 0.03). Additionally, in this study, the highest ADC value for a leiomyosarcoma was 1.095, with an intermediate DWI intensity. Based on these results, the patients were classified into 2 groups: low-risk group (barely any leiomyosarcoma risk) and high-risk group. Analyses comparing the 2 groups yielded the following: sensitivity, 100%; specificity, 94.0%; positive predictive value, 66.7%; negative predictive value, 100%; and accuracy, 94.6%. The study suggested that the modality using a combination of signal intensity on DWI and ADC value was very effective, simple, and easy to apply clinically for differential diagnosis of leiomyosarcoma and myoma.[11]

Wahab et al [2020] conducted a case-control retrospective study on women with atypical uterine masses and developed an MRI diagnostic algorithm that included enlarged lymph nodes, peritoneal implants, high diffusion-weighted MRI signal greater than that in endometrium, and

apparent diffusion coefficient less than or equal to 0.905 x 10^{-3} mm^2/sec enabled identification of leiomyosarcoma and correct classification in 40 of 42 (95%) patients in a validation set and 53 of 59 (95%) of examinations . A global or focal area of low T2 myometrial signal, a low or intermediate diffusion-weighted MRI signal less than that in endometrium, or absence of enlarged lymph nodes allowed a diagnosis of a uterine mass in two independent validation sets.[18-21]

Takeuchi et al [2009] evaluated 34 uterine myometrial lesions including 7 malignant tumors and 27 leiomyomas (6 cellular leiomyomas [CLM] and 21 degenerated leiomyomas [DLM]). The apparent diffusion coefficients (ADC) in cellular portions of the lesions were measured (10^{-3} mm^2/s). All malignant tumors showed high signal intensity on DWI with low ADC (mean [SD], 0.79 [0.26]), which was significantly lower ($P < 0.01$) than that in benign leiomyomas (1.51 [0.33]). The ADC in CLM (1.18 [0.16]) was significantly lower ($P < 0.01$) than that in DLM (1.60 [0.30]) and higher ($P < 0.05$) than that in malignant tumors. They concluded that it was difficult to differentiate malignant tumors from leiomyomas on the basis of signal intensity on DWI; however, the ADC measurements may be helpful to distinguish malignant tumors, CLM, and DLM. [22-25]

6.3 AIMS AND OBJECTIVES OF THE STUDY

1. To study the signal pattern of myometrial pathologies on Diffusion Weighted Imaging(DWI) .
2. To study the pattern of Apparent Diffusion Coefficient(ADC) values in different myometrial pathologies.

7. MATERIALS AND METHODS

7.1 Source of Data

Patients referred to the Department of Radiodiagnosis, Dayanand Medical College & Hospital, Ludhiana, Punjab for pelvic MR imaging.

7.2 METHOD OF COLLECTION OF DATA

This will be a prospective study done on all female patients undergoing pelvic MR imaging in the department of Radiodiagnosis and Imaging at Dayanand medical college and hospital over a period of 1 year from 1st March 2021 to 28th Feb 2022.

All patients with myometrial pathologies detected on MR imaging will be included. Written informed consent will be obtained from each patient and relevant detailed history will be elicited from all the patients. Procedure will be explained to the patient in his/her vernacular language to allay fear and anxiety.

INCLUSION CRITERIA:

- All-female patients with myometrial pathologies detected on pelvic MRI
- Clinical, surgical and histopathological follow up wherever possible

EXCLUSION CRITERIA:

- Patients with endometrial cancer and myometrial invasion will be excluded.
- Patients in whom ADC measurements of myometrium are not possible due to technical factors.
- All patients with contraindications for MRI(having cardiac pacemakers, prosthetic heart valves, cochlear implants or any metallic implants, having a history of claustrophobia)
- All patients who do not consent to be a part of the study.

MAGNETIC RESONANCE IMAGING PROTOCOL:

All patients will undergo a multiplanar, multi sequential MRI scan of pelvis on a MAGNETOM SKYRA 48 Channel 3 Tesla MRI Scanner by Siemens, Germany.

MR Imaging sequences will include a) T2 Weighted Sagittal b)T2 Weighted Axial c) T2 Weighted Coronal d) T1 Axial Imaging e)Diffusion

Weighted Imaging (DWI) in Sagittal and Axial plane acquired at 0,400 and 800 extrapolated to 1400-1600 by inbuilt software

f)contrast enhanced imaging : on discretion

The diagnosis of each pathological and histological type of uterine sarcoma will be established according to routine guidelines .The staging system to be applied is the new International Federation of Gynecology and Obstetrics system for uterine sarcoma[3]. ADCs have been calculated using DWI in many previous studies based on a mono exponential equation using only 2-point b-values (with zero as the low b-value) in pelvic MR imaging for women . ADCs calculated using this approach consist of a mixture of perfusion and diffusion information. Some studies have reported ADCs using multiple b values in various organs. According to the intravoxel incoherent motion (IVIM) DWI model, pure extravascular molecular diffusion and the microcirculation of blood within the capillaries (perfusion) can be separated using a biexponential decay function, providing additional parameters for characterization. Therefore we will be using ADCs that have been calculated by means of a biexponential equation using multi b-values, including those of myometrial tumors[1]. Hence ADC values would be acquired at 3 b-values of 0,400,800 s/mm^2.

<u>IMAGE ANALYSIS PROTOCOL:</u>

- For Diffusion Weighted Imaging :

  It will be performed in the axial plane of the uterus with a single-shot echo planar imaging (EPI) sequence using the following parameters: repetition time (TR)/echo time (TE), 8000 ms/99 ms; 5 mm slice thickness; field of view (FOV), 260 mm; matrix, 128646; and bandwidth, 1346 (Hz/Pz).

  The images will be acquired using three different high b-values (b 0, 400 and 800 s mm-^{2}) and the chemical shift selective fat suppression (CHESS) technique.

- For quantitative analysis:

  The ADC values of the myometrium will be measured on the ADC map images. Two oval regions of interest (ROI) will be

taken on myometrium excluding areas of necrosis, haemorrhage and cystic changes (as they impede accurate cell density evaluation) , and the ROI size and ADC values from the two ROIs will be measured. We will be measuring two ROIs and using the average value, rather than just one ROI, to reduce random variability in the measurements.

MR SYSTEMS AND SCANNING METHODS

Sequences	Localiser	T2 Sagittal	T1 Axial	T2 Axial	T1 Fat sat Axial	T2 Coronal	DWI	DCE	T1 PC Axial	T1 PC Coronal	T1 PC Sagittal
Acquisition Time	0:25	3:29	2:55	2:47	3:25	2:44	3:22	0:15	3:25	3:35	3:35
Orientation	Trans versal	Sagittal	Axial	Axial	Axial	Coronal	Axial	Axial	Axial	Coronal	Sagittal
Resolution Matrix	179 x 256	269 x 384	256 x 320	269 x 384	224 x 320	269 x 384	114 x 114	195 x 320	224 x 320	224 x 320	224 x 320
Number of Slices	9	25	25	25	25	25	25	80	25	25	25
FoV Read (mm)	420	230	220	220	220	230	220	350	220	220	220
FoV Phase (%)	100	100	100	100	100	100	100	81.3	100	100	100
Slice Thickness (mm)	7.0	3.0	3.0	3.0	3.0	3.0	3.0	1.2	3.5	3.5	3.5
Slice Gap (mm)	7.0	3.1	2.1	2.1	2.1	2.1	2.1	20%	2.4	2.8	2.8
Repetition Time (msec)	1000	2800	680	3100	60	2800	4000	3.42	600	630	630
Echo Time (msec)	89	87	18	89	20	87	64	1.24	20	20	20
Flip Angle (deg)	160	180	154	180	160	175	-	9	160	160	160
Fat Suppression	None	None	None	None	Fat sat	None	SPAIR	Q-fat sat	Fat sat	Fat sat	Fat sat
Flow Compensation	No	No	Read	Slice	No	No	-	-	No	No	No

Duration of Study/ Number of Cases

1 year from 1st March 2021 to 28th Feb 2022.

Outcome:

Diagnosing the pathological nature of myometrial lesions using diffusion weighted MR imaging and ADC values and correlation using clinical, histopathological examination wherever possible.

STATISTICAL ANALYSIS:

Data will be described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. Sensitivity, specificity, positive and negative predictive values and accuracy of method and its confidence interval (95% CI) will be also calculated. A probability value (p value) less than 0.05 will be considered statistically significant. All statistical calculations will be done using SPSS (Statistical Package for the Social Science) 21 version statistical program for Microsoft Windows.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

YES. The study is mainly based on investigations as Radiology itself is a tool of investigation. Interventions would be done as and when it is indicated alone. The study involves only humans. Informed consent would be taken after explaining about and before any procedure.

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Attached herewith

LIST OF REFERENCES

1. Togashi K, Ozasa H, Konishi I, Itoh H, Nishimura K, Fujisawa I, Noma S, Sagoh T, Minami S, Yamashita K. Enlarged uterus: differentiation between adenomyosis and leiomyoma with MR imaging. Radiology. 1989;171:531-4.
2. Le Bihan D, Breton E, Lallemand D, Grenier P, Cabanis E, Laval-Jeantet M. MR imaging of intravoxel incoherent motions: application to diffusion and perfusion in neurologic disorders. Radiology. 1986;161:401-7.
3. Li TQ, Takahashi AM, Hindmarsh T, Moseley ME. ADC mapping by means of a single-shot spiral MRI technique with application in acute cerebral ischemia. Magnetic Resonance in Medicine: An Official Journal of the International Society for Magnetic Resonance in Medicine. 1999;41:143-7.
4. Liu C, Liang C, Liu Z, Zhang S, Huang B. Intravoxel incoherent motion (IVIM) in evaluation of breast lesions: comparison with conventional DWI. European journal of radiology. 2013;82:e782-9.
5. Siegler AM, Camilien L. Adenomyosis. J Reprod Med. 1994;39:841–53
6. Ferenczy A Pathophysiology of adenomyosis. Hum Reprod Update. 1998;4:312–22
7. Tamai K, Togashi K, Ito T. MR imaging findings of adenomyosis: correlation with histopathologic features and diagnostic pitfalls. Radiographics. 2005;25:21–40
8. Jha RC, Zanello PA, Ascher SM, Rajan S. Diffusion-weighted imaging (DWI) of adenomyosis and fibroids of the uterus. Abdom Imaging. 2014;39:562-9.
9. Zaloudek CJ, Hendrickson MR, Soslow RA. Mesenchymal tumors of the uterus. In: Kurman RJ, Ellenson LH, Ronnett BM, eds. Blaustein's pathology of the female genital tract, 6th ed. New York: Springer; 2010:455-527.

10. Park JY, Park SK, Kim DY. The impact of tumor morcellation during surgery on the prognosis of patients with apparently early uterine leiomyosarcoma. Gynecol Oncol. 2011;122: 255-9
11. Sato K, Yuasa N, Fujita M, Fukushima Y. Clinical application of diffusion-weighted imaging for preoperative differentiation between uterine leiomyoma and leiomyosarcoma. Am J Obstet Gynecol. 2014;210:368-8.
12. Busard MPH, Mijatovic V, van Kuijk C, Pieters-van den Bos IC, Hompes PGA, van Waesberghe JHTM. Magnetic resonance imaging in the evaluation of (deep infiltrating) endometriosis: The value of diffusion-weighted imaging. J Magn Reson Imaging 2010;31:1117–1123
13. Li TQ, Takahashi AM, Hindmarsh T, Moseley ME. ADC mapping by means of a single-shot spiral MRI technique with application in acute cerebral ischemia. Magnetic Resonance in Medicine: An Official Journal of the International Society for Magnetic Resonance in Medicine. 1999;41:143-7.
14. Ogura A, Hayakawa K, Miyati T, Maeda F. Imaging parameter effects in apparent diffusion coefficient determination of magnetic resonance imaging. European journal of radiology. 2011;77:185-8.
15. Takeuchi M, Matsuzaki K, Nishitani H. Hyperintense uterine myometrial masses on T2-weighted magnetic resonance imaging: differentiation with diffusion-weighted magnetic resonance imaging. J Comput Assist Tomogr. 2009;33:834–7.
16. Namimoto T, Yamashita Y, Awai K, Nakaura T, Yanaga Y, Hirai T, et al. Combined use of T2-weighted and diffusion-weighted 3-T MR imaging for differentiating uterine sarcomas from benign leiomyomas. European radiology. 2009;19:2756-64
17. Tasaki A, Asatani MO, Umezu H, Kashima K, Enomoto T, Yoshimura N, et al. Differential diagnosis of uterine smooth muscle tumors using diffusion-weighted imaging: correlations with the apparent diffusion coefficient and cell density. Abdom Imaging. 2015;40:1742-52.

18. Ha HK, Jee MK, Lee HJ. MR imaging analysis of heterogeneous leiomyomas of the uterus. Front Biosci 1997;2:f4–f12.
19. Huang YT, Huang YL, Ng KK, Lin G. Current Status of Magnetic Resonance Imaging in Patients with Malignant Uterine Neoplasms: A Review. Korean J Radiol 2019;20:18–33.
20. DeMulder D, Ascher SM. Uterine Leiomyosarcoma: Can MRI Differentiate Leiomyosarcoma From Benign Leiomyoma Before Treatment? AJR Am J Roentgenol 2018;211:1405–15.
21. Abdel Wahab C, Jannot AS, Bonaffini PA, Bourillon C, Cornou C, Lefrère-Belda MA, et al. Diagnostic Algorithm to Differentiate Benign Atypical Leiomyomas from Malignant Uterine Sarcomas with Diffusion-weighted MRI. Radiology. 2020;297:361-71.
22. Whitten CR, DeSouza NM. Magnetic resonance imaging of uterine malignancies. Top Magn Reson Imaging. 2006;17:365Y377.
23. Tanaka YO, Nishida M, Tsunoda H, et al. Smooth muscle tumors of uncertain malignant potential and leiomyosarcomas of the uterus: MR findings. J Magn Reson Imaging. 2004;20:998Y1007.
24. Sahdev A, Sohaib SA, Jacobs I. MR imaging of uterine sarcomas. AJR Am J Roentgenol. 2001;177:1307Y1311.
25. Takeuchi M, Matsuzaki K, Nishitani H. Hyperintense uterine myometrial masses on T2-weighted magnetic resonance imaging: differentiation with diffusion-weighted magnetic resonance imaging. J Comput Assist Tomogr. 2009;33:834-7

PROFORMA

S.no

PATIENT DETAILS:

Name: Age and Sex : MRD No. :

Date of Scan :

Address : Mob. no. :

HISTORY

PRESENTING COMPLAINTS

- Abdominal heaviness:
- Abdominal distension:
- Abdominal pain:
- Abnormal vaginal discharge:
- Dysuria:
- Others:

MENSTRUAL HISTORY

- GTPAL score (Gravida Term Parity Abortion Living):
- LMP:____/_____/_____ (dd/mm/yy)
- PRE/POST MENOPAUSAL:
- CYCLES:Regular/ Irregular

  If Irregular - Amenorrhea /Polymenorrhea/Menorrhagia/Metrorrhagia/

- DYSMENORRHEA:

SIGNIFICANT FAMILY HISTORY: 1)Cancer 2)Others

Signature of Candidate **Signature of Supervisor**

BIOCHEMICAL ANALYSIS: 1)Hb 2)TLC 3)DLC 4)Plat 5) CA-125 3) CA-19-9 4)Creatinine

EXAMINATION

1)Pelvic examination: **2) PAP - smear :**

2) USG examination:

MRI FINDINGS

- Type of myometrial pathology:
- Total number of lesions:

S. No.	Size of Lesion	Location of Lesion	SI on T1	SI on T2	SI on DWI	ADC values	Post Contrast findings

Signature of Candidate **Signature of Supervisor**

PATIENT FOLLOW UP:

TREATMENT AVAILED/PLANNED:

HISTOPATHOLOGICAL EXAM (WHERE EVER APPLICABLE):

Signature of Candidate **Signature of Supervisor**

INFORMED PATIENT CONSENT

Date: _____

I.....D/o, W/o, S/o..... .....am willing to participate in the study **"ROLE OF DIFFUSION WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN MYOMETRIAL PATHOLOGIES"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

....

Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____

निवासी _____

इस शोधकार्य **"ROLE OF DIFFUSION WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN MYOMETRIAL PATHOLOGIES"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____
गवाह के हस्ताक्षर
नाम:

_____
रोगी के हस्ताक्षर/अंगूठे का निशान
नाम:

_____
अन्वेषक के हस्ताक्षर

_____
विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"ROLE OF DIFFUSION WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN MYOMETRIAL PATHOLOGIES" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ